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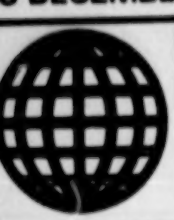

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UDC 536.421.4

Problems Concerning Phase Formation During Interaction of Solid Metal and Liquid Metal

18420275e Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 88 (manuscript received 14 Sep 87) pp 48-53

[Article by V. N. Pimenov and S. A. Maslyayev, Moscow]

[Abstract] The kinetic characteristics of phase layer build-up during interaction of a liquid metal and a solid metal as the latter dissolves are analyzed phenomenologically on the basis of the corresponding equation of mass balance at the interphase boundary. Both diffusive and convective modes of mass transfer in the melt are considered, with an either cylindrical or spherical interface and taking into account that the surface layer of an intermetallic compound in contact with the liquid metal continues to dissolve until the concentration of the dissolving metal reaches its saturation limit. The analytical solution to this equation indicates that a phase layer grows faster upon transition from diffusive to convective mass transfer, its growth rate being higher at a spherical interphase boundary than at a cylindrical and lowest at a flat plate. This has been confirmed by numerical solution, which also reveals the quantitative dependence of the phase growth rate on some process conditions such as diffusion or convection intensity and volumetric relations. References 15: all Russian.

UDC 541.11

Reversible Energy Storage

18420293a Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24 No 7, Jul 88 (manuscript received 29 May 85) pp 1061-1071

[Article by L. A. Reznitskiy, Moscow State University imeni M. V. Lomonosov]

[Abstract] This review of the primarily western literature briefly discusses the basic types of processes used for storage of thermal energy: phase transitions with latent heat of transition and reversible chemical reactions, primarily. Substances and processes are divided into two groups: substances and processes in the low temperature (273-423 K) area, and substances and processes in the area of higher temperatures (473-1270 K). A table lists the temperatures and enthalpies of melting of the crystal hydrates of various inorganic salts. An evaluation of the thermodynamic reference literature sources is presented to aid in selecting heat-storage substances and processes. References 60: 20 Russian, 40 Western.

UDC 546.682'.681'19

$In_xGa_{1-x}As$ Layers Grown by Molecular-Beam Epitaxy on the 100 face GaAs Substrates

18420293b Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24 No 7, Jul 88 (manuscript received 20 Aug 86) pp 1080-1084

[Article by G. G. Dvoryankina, V. F. Dvoryankin, A. G. Petrov, A .P. Porotikov, A. A. Kudryashov, A. B. Ormont, G. A. Varaksin, and L. B. Dlugach, Radio Engineering and Electronics Institute, USSR Academy of Sciences]

[Abstract] A study is made of the composition, structure and morphology of the surface, as well as the electrical and optical properties, of $In_xGa_{1-x}As$ layers (where x approximately equals 0.1-0.7), grown by molecular-beam epitaxy on Cr-doped on the 100 face GaAs substrates at a substrate temperature of 530°C from separate sources of In, Ga and As and the doping impurity Sn. The layers were 0.4-2.5 μm thick. Electron auger spectroscopy and x-ray microanalysis were used to determine the composition of the solid solutions in the layers and the heterogeneity of composition over the area of the specimens. Surface structure and morphology were studied. The morphologic specifics of the surface were analyzed as a function of solid solution composition. Electrical and optical properties of the layers obtained were measured. References 6: 1 Russian, 5 Western (1 in Russian translation).

UDC 621.357

Technology and Economics Galvanization

18420273a Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 126-126

[Article by M. I. Garber, chief project designer, Planning and Technological Bureau, USSR Ministry of Communications, Moscow]

[Abstract] Recent progress and current trends in the Soviet galvanization industry are reviewed in terms of technological improvements and economics, the principal products of this industry, apart from electroplated Zn coatings, being electroplated Ni and Cr coatings. An analysis of production data reveals the impact of new materials and methods on the cost structure of the electroplating process, typical examples being the change from cyanide bath to noncyanidic baths for Zn-plating, from disulfonaphthalic acid bath to butnydiol bath with NIA-1 for Ni-plating, and from standard bath to low-temperature bath for Cr-plating. The major problems are inefficient use of costly and scarce nonferrous metals such as Cd in the galvanizing process, high cost of treating waste water, and the ecological as well as health hazard of synthetic surfactants. It is noteworthy that in some cases an alloy coating may have better performance characteristics and cost less to produce. A single layer of Ni-Pd alloy coating, for example, is preferable to a two-layer Ni and Pd coating. The trends in the industry are toward more extensive production of alloy coatings and development of new electrolytes for this purpose, toward use of simple diluted electrolytes in cold baths, toward more extensive use of harmless detergents and inhibitors, toward a higher degree of automation, and toward in situ surface treatment prior to electroplating. References 11: all Russian.

UDC 621.357

Wear-Resistant and Antifrictional Coatings

18420273b Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 126-138

[Article by A. F. Ivanov, candidate of technical sciences, chief production engineer, Monometr MO]

[Abstract] Electrodeposition of wear-resistant and antifrictional coating is surveyed, materials for such coatings having been classified into 11 groups, each for a specific type of surface and service: 1) chromium and Cr-base alloys with V, Mo, Nb, 2) iron and Fe-base alloys with C (steel), Mn, Ni, B, P, Al_2O_3, ZrO_2, 3) molybdenum and tungsten alloys with Fe, Co, Ni, 4) wear-resistant oxides, 5) nickel alloys with In, Re, B, P and nickel composites with graphite, SiC, TiC, WC, MoS_2, Al_2O_3, ZrO_2, 6) copper and Cu-base alloys with Dc, In, Sn (bronzes), Sb, Pb, 7) lead and Pb-base alloys with In, Sn, 8) silver and Ag-base alloys with Sn, Sb, Pb, 9) gold and Au-base alloys with Ni, Co, Cu. Pd, Ag, Sb, 10) indium and in-base alloys with Ni, Co, Zn, Cd, Ag, Pb. 11) gallium. The appropriate electrolytes and plating conditions (bath temperature and cathodic current density) are listed for each coating material. References 50: all Russian.

UDC 541.182;620.1:621.793

Composite Coatings

18420273c Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 138-146

[Article by R. S. Sayfullin, doctor of technical sciences, professor, department head, Kazan Chemical Technology Institute imeni S. M. Kirov]

[Abstract] The theory and practice of producing composite coatings are overviewed, the conventional electrochemical methods of their deposition being either from electrolyte in suspension during deoxidation of the base metal surface or from colloidal solution or "pure" electrolyte which forms such a solution at the electrode surface. The materials commonly used for the disperse phase-II are low-temperature cubic Al_2O_3, SiO_2 aerosol, and current-conducting borides (TiB_2, CrB_2, ZrB_2), carbides TiC, CrC_2), nitrides (alpha-BN), MoS_2, no consistent and reliable data being as yet available on Co-C, Ni-C, Cu-C, Ag-C composites. Selection of the phase-II material is determined by the coating requirements and is based on comparative evaluation of the characteristics of those available. The most widely produced composite electrochemical coatings and their physical properties are accordingly described. No definitive theory of the electrochemical codeposition mechanisms such as in the case of Al_2O_3 and Ag is yet agreed upon, by various hypotheses have been proposed and experimentally supported. Nonconventional methods of depositing composite coatings are electrodeposition of ultra-microcomposites already formed in the electrolyte, anodic electrodeposition, plasmochemical deposition and ion implantation, and chemical deposition without electric current. The deposition rate can be increased appreciably by frictional abrasion of the surface and resulting cancellation of the concentration polarization. Electrodeposition of metallic alloy coatings can be optimized by use of self-regulating electrolyte suspensions. The electrodeposition process can be controlled by varying either the ion content in the suspension or the operating mode of the electrical apparatus. References 81: 60 Russian, 20 Western, 3 German.

UDC 621.357.7:661.18:847.571(043.3)

Use of Electrochemical Alloy Coatings in Functional Galvanization Technology
18420273d Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 146-152

[Article by K. M. Tyutina, candidate of technical sciences, professor, vice chancellor, and L. V. Kosmodamianskaya, candidate of technical sciences, senior scientific associate, Department of Electrochemical Production Technology, Moscow Chemical Technology Institute imeni D. I. Mendeleyev]

[Abstract] A class of special-purpose metallic alloys for electrochemical coating of metal parts prior to soldering is surveyed, alloys for such coatings being required to have long storage life as well as high corrosion resistance, low electrical resistivity, and adequate plasticity or mechanical strength. From a large assortment of tin alloys experimentally developed so far, Sn-Pb (61-39), Sn-Cu (50-90 pct Cu), Sn-Ni (35-40 pct Ni), and Sn-Bi (0.1-2 pct Bi) are selected for consideration on the basis of technological and economic criteria, a major advantage being that they do not contain precious or scarce metals. Electrolytes used for the deposition of each and the respective galvanization process characteristics are listed. References 31: 21 Russian, 10 Western.

UDC 621.357.7

Spontaneous Growth of Whiskers on Coatings
18420273e Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 152-157

[Article by V. K. Glazunova, candidate of chemical sciences, and K. M. Gorbunova, doctor of chemical sciences, professor, scientific consultant, Physical Chemistry Institute, USSR Academy of sciences]

[Abstract] Spontaneous growth of tin whiskers on the surface of tin and Sn-alloy coatings is overviewed, with emphasis on its detrimental effect on the coating performance and possible countermeasures. Such whiskers, 0.001-0.002 mm thick and up to 5 mm long, are tetragonal single crystals with the C-axis in the direction of growth usually appearing alongside thicker and much shorter helices. They have the basic properties of tin, with the ability to conduct large electric current without melting or burning. Their growth kinetics and structure are influenced by the ambient medium and the metal under the coating, also by the mode of their electrodeposition and subsequent heat treatment. No whiskers have been detected on SN-alloy coatings (Sn-Pb, Sn-Cu, Sn-Ni) with a high content of the other metal. The growth of whiskers can be inhibited by making the coating sufficiently thick (at least 0.006 mm), by depositing it on a Ni interlayer, by removal of Cu and Zn ions from the electrolyte and limiting the use of brighteners, and by heat treatment of tin and low-alloy tin coatings at 170-190 deg C for 1-2 h or at 150-170 deg C for 2-3 h. References 22: 6 Russian, 14 Western, 2 German.

UDC 621.3:793.543.42

New Applications for and Distinctive Structural Features of Chemically Deposited Coatings
18420273f Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 157-164

[Article by K. M. Gorbunova, doctor of chemical sciences, professor, scientific consultant, and M. V. Ivanov, candidate of chemical sciences, chief scientific associate, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] Two new areas of application for chemically deposited coatings are considered, i.e., as protection of electric and electronic equipment against electromagnetic interference and as magnetic information carriers. Following a review of shielding and attenuation requirements, the characteristics of coating materials and deposition processes are comparatively evaluated from the standpoint of meeting these requirements and taking into account the fact that the present 60 Hz - 1000 MHz frequency range of electromagnetic interference is expected to extend to 140 GHz in the future. The trend here is toward use of varnishes with metal (Ni, Cu, Ag) or graphite inclusions or conducting plastics where they can replace Al, Ni, Ni-P, Cu foils. Following a review of trends in magnetic recording, longitudinal and vertical, magnetic coating materials and their chemical deposition are evaluated relative to electrochemically deposited ones, taking into account the distinctive structurization requirements. Both new applications are being developed with the aid of scanning transmission electron microscopy, X-ray diffractometry, and a variety of spectroscopic methods. References 44: 6 Russian, 36 Western, 2 German.

UDC
541.13:621.357.7:621.357.74:621.357.75:621.792.4

Galvanic Coatings for Stronger Adhesion to Polymers
18420273g Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 2, Mar-Apr 88 pp 164-171

[Article by S. S. Kruglikov, doctor of chemical sciences, professor, and T. A. Bagranyan, candidate of chemical sciences, docent, Department of Electrochemical Production Technology, Moscow Chemical Technology Institute imeni D.I. Mendeleyev]

[Abstract] Electrodeposition of adhesive metal and alloy coatings on metal surfaces for better adhesion to polymers in composite structures is described, in one typical

case of printed-circuit boards a smooth copper surface being coated with a rough copper layer for better adhesion to the dielectric plate and in another case steel wire being brass-plated for better adhesion to rubber when cut. The optimum electrodeposition mode and prior surface treatment depend on the base metal and in each case on its original microroughness, in the case of steel most importantly on the grade of brass. Codeposition of Cu and Zn is difficult, because of the large difference between their standard potentials, Cu ions being preferably combined into complexes stronger than Zn ions. More effective electrolytes and more productive, as well as more economical, electrodeposition electrolytes and more productive, as well as more economical, electrodeposition processes yielding high-quality coatings with minimum current consumption are still being sought, through extensive experimental studies including chemical and phase analyses as well as electrical measurements and mechanical tests. References 35: 17 Russian, 16 Western, 2 German.

UDC 620.196.2:669.14

Influence of Phosphorus and Carbon on Intercrystalline Corrosion of Kh18N11 Steel in Nitrate Media

18420016a Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 25 Jun 87) pp 559-568

[Article by L. P. Lozovatskaya, N. A. Kozhevnikova, O. V. Kasparova, S. D. Bogolyubskiy, V. M. Milman, N. M. Ostrikova, and M. M. Nogina, State Scientific Research and Design Institute of the Nitrogen Industry and Products of Organic Synthesis; Physical Chemistry Scientific Research Institute imeni L. Ya. Karpov; Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin]

[Abstract] An estimate is presented of the intercrystalline corrosion tendency of low-silicon steels as a function of their carbon and phosphorus content. The corrosion rate of 21 different melts was determined by mass loss for each test cycle. Intercrystalline corrosion depth was determined metallographically after the final test cycle. Corrosion tests were performed in boiling solutions of 65, 72 and 80 percent HNO_3, 5 cycles of 48 hours each, in 80 percent HNO_3 at 70-100 °C, 3 cycles of 100 hours each, and in 85 percent HNO_3 at 60-90 °C, 5 cyles of 100 hours each. Corrosion damage was measured using a scanning electron microscope; the structure of the steels after tempering at 650 °C for 1 hour was determined by means of a light microscope and an electron microscope. It was found that decreasing the content of carbon and phosphorus can increase resistance to intercrystalline corrosion in nitrate media, particularly when the content of both elements is reduced simultaneously. Good resistance to intercrystalline corrosion in 65 percent HNO_3 is achieved by reducing phosphorus content to not over 0.03 percent, carbon content to not over 0.025 percent. Decreasing the phosphorus content to not over 0.015 percent allows the temperature-concentration limits to be increased still further, concentration to 80 percent HNO_3 and temperature of 80-85 percent HNO_3 by at least 10 °C. References 30: 14 Russian, 16 Western.

UDC 620.197.1

Scientific-Technical, Economic, and Social Aspects of Anti-Corrosion Protection

18420247a Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian Vol 33 No 3, May-Jun 88 pp 243-247

[Article by V. A. Timonin, doctor of chemical sciences, professor, director, All-Union Scientific Research Institute for the Protection of Metal Against Corrosion, Moscow]

[Abstract] Two basic methods of anti-corrosion protection, namely coating with paint or varnish and use of corrosion-resistant alloy steels or other alloys, are reviewed from the standpoint of technological developments over the 1955-84 period in the USSR and worldwide, particularly in the United States and Japan. Production statistics pertaining to steels, ferroalloys, and titanium are cited which indicate, for example, that the production of paints and varnishes does not keep up with production of steel. Patenting activity in the USSR, as well as in Japan, indicates a marked shift since 1970 from development of new corrosion inhibitors and electrochemical methods toward optimization of existing methods combined with better corrosion monitoring techniques. An interesting trend in the United States is a gradual redistribution of the demand for titanium relative to other materials, its use by the military-aerospace industry decreasing and its use by the chemical industry increasing. Both the economic and ecological impacts of corrosion are discussed, the need for extensive protection against it being closely related to the problem of waste disposal and to preservation of a safe environment. References 26: 21 Russian, 5 Western.

UDC 621.794:620.197

Progress and Further Possibilities in Chemical Treatment of Metal Surfaces

18420247b Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian Vol 33 No 3, May-Jun 88 pp 248-253

[Article by Ya. N. Lipkin, candidate of chemical sciences, head of the processes and equipment for chemical treatment of pipes laboratory, Ural Scientific Research Institute of the Pipe Industry, Chelyabinsk]

[Abstract] Developments in the chemical treatment of metal surfaces and particularly steel surfaces are reviewed, such treatment including purification of surface, deposition of primer or adhesive coating, special treatment, deposition of temporary coating, intermediate protection and protection against corrosion. Following an overview of chemical reactions which occur at the surface, surface treatment applicable to manufacture pipes is discussed. Progress in use of detergents and surfactants as well as new coating materials and processes are evaluated from the standpoint of reliability. The importance of surface preparation prior to treatment is emphasized. A comparative cost analysis of chemical and mechanical treatment is shown to indicate that chemical treatment is more economical for large specific surface areas (m^2/ton) and high production volumes. Further requirements pertaining to the entire technological base for chemical surface treatment are defined. References 137: 107 Russian, 22 Western, 8 German.

UDC 667.649.49

Electrolytic Deposition of Organic Coatings
18420247c Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 3, May-Jun 88 pp 254-264

[Article by V. P. Barabanov, doctor of chemical sciences, professor, head, Department of Polymer Physical Chemistry, and G.Ya. Vyaseleva, candidate of chemical sciences, docent, Kazan Chemical Technology Institute imeni S.M. Kirov]

[Abstract] Classification and characterization of polymers usable for coating metal surfaces is followed by an overview of cathodic electrodeposition processes, colloidal and nonaqueous as well as water-soluble electrolytes being used for electrodeposition of polymers. Ionization-dissociation of film-forming substances is most essential here, only relatively few cathodic polymer electrolytes having been developed so far and their insolubility in water impeding further progress in this area inasmuch as water-soluble electrolytes are preferable. Both the physics and the chemistry of film formation on the cathode surface are outlines for an understanding of the electrodeposition technology. Preparation of the surface for coating is shown to be essential for ensuring adequate dispersion of the polymer and effective buildup of a film. The two main process characteristics are current efficiency of polymer yield and deposition rate, the latter tending to decrease as film builds up so that total deposition time becomes another important parameter. The deposition rate increases with increasing molecular mass, but with it increases also the porosity of the coating and this limits the maximum allowable size of macromolecules in any given kind of electrolyte. Electrodeposition of composite polymers offers excellent possibilities of producing high-quality coatings, one method involving prior deposition of one component on the anode surface and subsequent absorption of the other component before both are together transferred to the cathode surface. References 150: 88 Russian, 1 Yugoslav(?), 53 Western (2 in Russian translation), 8 German.

UDC 620.197:6:678

Protective Polymer Coatings
18420247d Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 3, May-Jun 88 pp 264-270

[Article by V. A. Murov, candidate of technical sciences, docent, Moscow Chemical Machine Building Institute]

[Abstract] The performance and design of anticorrosive polymer coatings are overviewed, low cost being the main incentive for their use in preference to other coatings despite their poorer performance. Their action, based on a combination of physical and chemical factors, depends essentially on the conditions under which they are to prevent direct contact between bare metal, such as steel, and aggressive medium. Polymer coatings are not impermeable; they allow some transfer of corrosive agents and corrosion products by diffusion. They are dielectric, capable of electrochemically protecting and passivating the metal underneath. The three criteria of their viability in an aggressive medium are, in the order of decreasing rank, retention of continuity, retention of adhesive strength, and corrosion rate of the metal underneath. Loss of continuity and loss of adhesive strength occur by various mechanisms depending on the type of medium and the state of stress under given ambient conditions, heating and cooling adding to the severity. Sorption and corrosion date pertaining to carbon steels under polymer coatings in media with up to and above critical concentration of volatile acids (HCl, HF, HNO_3) or nonvolatile ones (Ch COOH, H_2SO_4) are interpreted in terms of these mechanisms. The specific polymer material is selected accordingly and the necessary coating thickness is determined on the basis of the two fundamental corrosion laws. Methods of corrosion monitoring and stress measurement are available for quality control. References 76: 45 Russian, 29 Western (1 in Russian translation), 2 German.

UDC 667

Improving Protective Characteristics of Nonmetallic Corrosion-Resistant
18420247e Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 3, May-Jun 88 pp 271-276

[Article by O.L. Figovskiy, candidate of technical sciences, head, Department of Protection against Corrosion, All-Union Scientific Research Institute for the Protection of Metal against Corrosion]

[Abstract] Methods of improving the protective characteristics and lengthening the life of nonmetallic anticorrosive coatings such as polymer and silicate ones are overviewed, the problem being to minimize the migration rate of corrosive agents to the metal surface and the corrosion rate of the metal under the coating, to minimize the coating defectiveness and chemical decomposition and rate as well as internal stresses produced in the coating during deposition and in service, and to maximize the adhesive strength of the coating-metal system. This is achieved by modification of the chemical structure of the material or the macrostructure of the coating layer. Relatively stable carbon chains are further stabilized by introduction of fluorine atoms. Much less stable heterochains are modified by decreasing the number of hydrolytically unstable bonds and increasing the number of aromatic or bisaromatic rings. Silicates of alkali metals are stabilized by addition of tetrafurfuryl oxysilane. Addition of absorbents, powders of metal oxides

such as Al_2O_3 and CuO, makes polymers such as low-density polyethylene and composites such as epoxy-shale less permeable, the optimum weight fraction of these additives for maximum adhesive strength as well as minimum permeability depending on the nature of the aggressive medium. Composite coatings have excellent performance characteristics, especially when laminated into a heterogenous structure or reinforced with a fibrous material such as carbon cloth. Development of these methods is being supported by theoretical and experimental studies, namely stress and stress kinetics analysis, stress and corrosion measurements, chemokinetics as well as chemical and phase analyses, microstructural examination by x-ray diffraction and under electron microscope, infrared and NMR spectroscopy. References 64: 58 Russian, 3 Western, 3 German.

UDC 620.197.6:666.964

Inhibited Bituminous Protective Coatings
18420247f Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 3, May-Jun 88 pp 277-281

[Article by Yu. N. Shekhter, doctor of technical sciences, professor, department head, and I. Sh. Bogdanov, scientific associate, All-Union Petroleum Refining Scientific Institute, Moscow]

[Abstract] The physical properties and chemical structure of natural and synthetic bituminous coatings for protecting metal against corrosion are reviewed. The performance of such coatings alone is relatively poor but can be greatly improved by means of modifiers. The basic material consists of asphalt or asphaltite (asphaltene), resin, and oil, and depending on the relative amounts of these ingredients, the material is a gel, a sol, or a gel-sol hybrid. Polymers, elastomers, mineral fillers, or plasticizers, as modifiers and are added, but only corrosion-inhibiting surfactant films are capable of speedily and reliably clearing the metal surface of corrosive electrolyte. The mechanism and the kinetic characterizing the protective action of bituminous coatings inhibited with film-forming petroleum fractionation products in the presence of air are explained graphically. Their bulk and surface properties as well as performance characteristics are tabulated for a comparative evaluation of eight such inhibitors (NG-216A, NG-216B, Antikorrozin, NGM-Shassi, MOPL-3, Ingibit S, Ingibit Zh, Kabinor) produced by Soviet industry, each for a specific application (NGM-Shassi for automobile chassis). References 29: all Russian.

UDC 621.357

Soft Gold Plating
18420247g Moscow ZHURNAL VSESOYUZNOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDELEYEVA in Russian
Vol 33 No 3, May-Jun 88 pp 314-318

[Article by Ye.A. Yefimov, doctor of chemical sciences, professor, Department of Metal Corrosion and Protection, Moscow Evening Metallurgical Institute]

[Abstract] Following a review of the electrochemical gold plating mechanism, the performance of seven electrolytes for cathodic soft gold plating is evaluated in terms of polarization characteristics at room temperature and 65-70 deg C. Production of pure Au coatings, Au coatings with up to 1 pct impurity metal (Co, Ni), and Au with Cu coatings is considered. Codeposition of Ni is much more difficult than codeposition of Cu, but even Cu eventually parts from the coating with only traces left after a longer period of time in service. The most extensively used electrolytes are potassium citrate and potassium citrate-phosphate with $KAu(CN)_2$. Au or Pt have been used as anode material, but oxide-coated Ru-Ti anodes have been recently found to slow down oxidation of the $C_6H_5O_7^{3-}$ anion. References 15: 12 Russian, 3 Western.

539.04:621.039.616

Damaging Effect of Low-Energy Xenon Ions on Copper
18420275a Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 88 (manuscript received 24 Sep 87) pp 11-13

[Article by A. A. Babad-Zakhryapin and V. A. Popenko, Moscow]

[Abstract] An experimental study concerning the effect of the bombardment of metals by low-energy ions, specifically of copper by Xe ions with a close to threshold energy below 200 eV, was made for the purpose of detecting an explicit energy dependence of their damaging far-range action. Specimens of 0.010 mm thick MOb-grade Cu foils, after annealing at a temperature of 900 K under vacuum for 1 h, were bombarded on one side with 30-150 eV Xe ions from a TE-O accelerator with a flux density of 8.10^{16} ions/(cm^2.s). The foil temperature on this side was monitored with a thermocouple through a junction made of Wood's metal, while the other side of the foil was maintained at room temperature by water cooling. Radiative heating was estimated from the hot-spot temperature and the damaging bombardment dose was estimated by dividing the cross-section for interaction by the bombardment time. Microstructural examination of the surface layer, before and after bombardment, in a DRON-3 x-ray diffractometer with CuK_{alpha}-radiation source and monochromator has revealed a decreasing lattice period and an increasing integral intensity of diffraction lines across the entire foil thickness. A harmonic analysis of the profiles of (200) and (400) diffraction lines has established that the defects in annealed Cu foil are of the dislocation kind and cause lattice distortions around them which decrease with increasing distance from these defects. In a Cu foil after annealing they taper off slowly, while in a subsequently bombarded one they taper off fast and thus indicate formation of space-limited dislocation loops and point defects. The cross-section for interaction was calculated on the basis of the Born-Mayer potential with Brinkman constants. References 10: 7 Russian, 3 Western (1 in Russian translation).

UDC 620.193.01

Influence of Surface Treatment on Resistance of VT1-0 Titanium to Hydrogenation and Corrosion During Cathodic Polarization
18420016b Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 17 Mar 87) pp 569-574

[Article by I. V. Kasatkina, A. I. Shcherbakov, V. N. Modestova, and N. D. Tomashov, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] A detailed study is made of the influence of surface chemical and heat treatment of a titanium cathode on hydrogenation and corrosion. It was assumed that the presence of coatings formed by interstitial elements such as oxygen, boron and carbon might decrease the absorption of hydrogen and hinder hydride growth. Films were formed by anodic treatment and thermal oxidation in air. The coatings studied, although they reduced hydrogenation, actually decreased the resistance of the titanium to "hydrogen corrosion," except for the anodic-oxide coating. Anodically oxidized titanium was equally resistant to corrosion as the initial titanium but was hydrogenated half as rapidly. The coating must be periodically renewed to retain its effectiveness. It was found that titanium hydride grows on each grain individually, repeating the configuration of the base grains. The major reason for breakdown of hydride and hydrogen corrosion of titanium is the development of internal stresses and insufficient stress relaxation in surface layers of the metal as the hydride grows. Decreasing residual hydrogenation thus does not necessarily eliminate hydrogen corrosion. Surface treatment must improve the structure of the surface and subsurface metal layers by the creation of favorable crystallographic orientation to reduce internal stresses and by facilitating relaxation of internal stresses. Thermal oxidation, carbidization and diboride coating are not effective means of protection. Creation of optimal structure in the surface titanium layer is more promising. References 10: 8 Russian, 2 Western.

UDC 621.357.74:669.5

Influence of Zinc Plating Electrolyte Composition on Anticorrosion Properties of Coatings
18420016c Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 24 Apr 87) pp 594-597

[Article by S.Ya. Grilikhes and T.A. Yevseyeva]

[Abstract] A study is made of the extent to which organic compounds present in electrolytes containing surfactants can improve the protective properties of zinc coatings without having an unfavorable influence on other properties related to the metal surface condition. The influence of the addition of certain surfactants to electrolytes for zinc plating on the anticorrosion properties of coatings and their capacity for soldering was studied. The use of surfactants is recommended for improvement of the anticorrosion properties of zinc coatings on parts which need not be soldered, allowing coatings to be 30-40 percent less thick than is normally recommended. The resistivity of the coatings is significantly increased by the use of electrolytes containing surfactants, making them less suitable for applications involving soldering. References 6: 5 Russian, 1 Western.

UDC 620.193.01

Determining Critical Pitting Size on Stainless Steel
18420016d Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 27 Mar 87) pp 614-617

[Article by L. I. Freyman, A. R. Basman, Ye. A. Pikus and L. Ye. Gudzhabidze, Academy of Municipal Services imeni K.D. Damfilov; Metallurgy Institute imeni the 30th Anniversary of the USSR, Georgian Academy of Sciences; Republic Center of Electron Microscopy of the Georgian Polytechnical Institute imeni V. I. Lenin]

[Abstract] The critical pitting diameter was determined by an automatic quantitative metallography method used previously to determine the distribution of pitting apertures by diameters. Specimens of stainless 12Kh18N10T steel were used, with studies performed on the top, polished end of a cylinder, area 0.1 cm^2. Electrodes were anodically polarized in the galvanostatic mode in naturally aerated 1.4 and 0.4 M NaCl solutions at 25 °C. Pit formation was studied by photographing the surface of the specimen on a scanning electron microscope, at least 10 frames showing $2.225 \cdot 10^{-4} cm^2$ per frame. An equation is derived for construction of a calculated repassivating pit curve showing the distribution by radius at any moment in time. Although the method involves a good deal of labor, it provides an accurate determination of the critical pitting radius and mean radius of repassivated pits as functions of time. References 9: 3 Russian, 6 Western.

UDC 620.193.4

Identification of Atmospheric Corrosion Products Formed on Zinc and Cadmium Coatings Under Tropical Conditions In Vietnam
18420016e Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 5 Feb 87) pp 643-647

[Article by Vu Din Vuy, A. A. Mikhaylov, G. M. Plavnik, and G. N. Troshkin; Institute of Tropical Technology, National Scientific Research Center, Republic of Vietnam; Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] The phase composition of corrosion products determined radiographically on zinc and cadmium coatings 24μm in thickness over steel after various times of

exposure at eight corrosion stations in northern, central and southern Vietnam is presented. A possible mechanism is suggested for the formation of the compounds identified in atmospheric corrosion products of the coatings. The major purpose of the work was to identify the corrosion products following five years exposure at the eight corrosion stations. Products included basic and, less frequently, neutral zinc sulfate and basic carbonates which are reformed to sulfates over time as a result of periodic sulfur contamination of the atmosphere. No zinc chlorides were found. Cadmium coatings corrode forming the carbonate and hydroxides, and in marine atmospheres, basic cadmium chloride. The composition of the corrosion products depends on the type of atmosphere and time of exposure, particularly for zinc. References 15: 7 Russian, 8 Western (3 in Russian translation).

UDC 541.144.7

Study of Corrosion Behavior of Metals and Composition of Overgrowth in Tsemesskaya Bay

18420016f Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 13 Feb 86) pp 647-652

[Article by Yu. M. Korovin, T. A. Lukasheva, and A. V. Ledenev, Institute of Oceanology, USSR Academy of Sciences, Southern Department]

[Abstract] The purpose of this work was a complex study of the behavior of a number of structural materials and the formation of macroscopic and microscopic overgrowth on them. Specimens measuring 100x50x2 mm were attached by PVC tubing to frames immersed about 4 m beneath the surface of the Black Sea for 3, 6 and 12 months. Specimens were degreased, weighed and then immersed after sterilization with alcohol. Corrosion results were averaged over two specimens of type St3 carbon steel, M-1 copper, LS-59-1 brass, AMts-3 and AMg-5M aluminum alloys, Kh18N10T stainless steel and VT-5 titanium. In order of increasing corrosion resistance, the specimens were found to be steel, copper, brass, AMts-3, AMg-5m, stainless steel and titanium. Macroorganisms were found to settle and actively develop on corrosion-resistant metals or on those in which the corrosion products were located over a small surface, since the organisms require good binding with the substrate. Microscopic overgrowth developed more rapidly on surfaces with large quantities of corrosion products, on which organic matter was adsorbed and thus available for feeding the bacteria. References 3: all Russian.

UDC 620.199

Rapid Chemical Determination of Intercrystalline Corrosion Resistance of Corrosion-Resistant Steels

18420016g Moscow ZASHCHITA METALLOV in Russian Vol 24 No 4, Jul-Aug 88 (manuscript received 16 Jul 86) pp 706-709

[Article by I. G. Volikova, T. V. Strelkova, Ye. L. Rodicheva, and T. V. Petrova, All-Union Scientific Research and Design Institute of Chemical Machine-Building]

[Abstract] The authors' institute has developed a rapid chemical method of determining the intercrystalline corrosion resistance of corrosion-resistant metals, using a solution containing 250 ml sulfuric acid, 1 liter of water, 50 g copper sulfate, and 128 g sodium fluoride. Tests are performed in polyethylene vessels at 20-25 °C with copper present. Test times are 1 to 3 hours. Comparison testing with the standard method called for in the state standards yielded 100 percent agreement. References 3: all Russian.

New Technology: Converting Metal to Amorphous State

18420005 Moscow ADVANCES OF SCIENCE AND TECHNOLOGY in English No 11, 15 Apr 88

[Article by Dmitry Sasorov, APN Correspondent]

[Text] We remember since our school days that amorphism is the state of a solid lacking a crystal structure. Typical of them are uniform physical properties in all directions. A classic example is window glass. Steel, too, could be amorphous if it could be made without a crystal lattice. This is what gives metal its high resistance to corrosion, strength and durability. But how do we get such a metal?

It was produced in a laboratory in the Ukrainian city of Dnepropetrovsk late in the 1930s by sheer accident. At that time science could not explain the nature of the phenomenon, and the discovery was abandoned as useless. Only decades later, in the 1970s, scientists resumed their quest for the evasive metal. Their consistent efforts have led to its rediscovery at the Moscow-based Bardin Central Research Institute for Ferrous Metallurgy. I talked to Professor Molotilov, Doctor of Engineering, USSR State Prize winner and director of the Institute, and he said.

"Our Institute researchers take full credit for the rediscovery of amorphous metal and its commercial production technology. It has been a long-cherished dream of all metallurgical workers to produce rolled stock directly from the molten mass, by-passing the stages of ingot moulding, forging, thermal treatment and machining.

"The years of painstaking R&D efforts have been crowned with success. Today, 4 Soviet steel works are turning out 10 grades of amorphous steel."

At the Institute I was given a guided tour of production shops to get an idea about the technology and techniques of amorphous metal production.

A small cylinder-shaped shell is filled with powdered metal and aftercharge. Being part of a vacuum induction furnace, the shell is the place where metal is smelted. The fiery mass leaves the shell through a die in the bottom section of the shell in strictly rationed dozes and is fed to the rotating copper disk. A drop of metal is evenly distributed by centrifugal force all over the disk's surface and leaves it in a form of a continuous wire strand or foil as dazzling as stainless steel.

The resulting metal strip can be of any required thickness and width, depending on the profile or size of the die. It leaves the disk at a speed of 8 kilometres per minute and solidifies at a rate of over a million degrees per second. I was there, saw the technology in action, and still don't believe my eyes. This unprecedented technology has given us the means to produce amorphous metal in commercial quantities. It finds numerous applications in electrical engineering, medical equipment, communication facilities, mechanical engineering and instrument making, and in automatic systems—in every job which requires temperatures of plus 400 to 500 degrees Centigrade. At a higher temperature metal acquires a crystal lattice and loses its invaluable properties.

The replacement of electrical steel in substation transformers with the amorphous grade would result in an almost 67 percent drop in the noise and thermal electricity losses. Another thing is that amorphous steel loses none of its properties for 50 years.

I was shown a piece of foil, sharp as a razor blade and practically wear- and tear-proof. Imagine safety razor blades made of this metal. I mention the idea to Professor Molotilov.

"We have already thought about this together with our colleagues from Kiev," he replies.

Question: What are your immediate plans?

Answer: The Ministry of Ferrous Metallurgy has already set up a special engineering centre responsible for the production and application of amorphous and microcrystal materials under the direction of Minister Serafim Kolpakov, Doctor of Engineering. The centre is an inter-branch agency, involving 12 industries.

Question: Is any other country interested in this area of metallurgy?

Answer: I can tell you that several CMEA countries have been cooperating with us in this area under a comprehensive programme for scientific and technological integration. Very active research is going on in China and India. Commercial production of this grade of metal has been launched in Japan, the United States and West Germany. I am proud to say that we are leading in some fields. Two of 10 grades of amorphous steel produced in the USSR have better characteristics than any foreign-made metal. Others are about the same quality.

Soviet Plant Installment Backlog

18420272 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 8 Jun 88 p 2

[Article by N. Lushchenko, USSR Deputy Minister of Ferrous Metallurgy: "Imports—Waiting To Be Claimed," with the subheading "The newspaper has spoken. What was done about it?"]

[Text] The USSR Ministry of Ferrous Metallurgy has reviewed the article "Imports—Waiting To Be Claimed," published on 30 December 1987, and notes that it correctly represents the shortcomings in the work of the enterprises and the ministry in utilizing uninstalled equipment, including imported, as well as the facts concerning the unthrifty attitude toward physical assets.

Because of systematic nonfulfillment of the plans of capital construction in 1981-1985, corrections to the annual plans and disproportions in the scheduling of orders and arrival of equipment with the funds actually allocated, the reserve of noninstalled equipment as of 1 January 1986 amounted to 1471.1 million rubles, including 920.2 million rubles of imports. As a result of measures adopted during 1986-1987, the ministry succeeded in drastically reducing the volumes of uninstalled equipment to 766.5 million rubles (including imports down to 254 million rubles) as of 1 January 1988. The surplus reserve of uninstalled equipment was reduced during this period from 290.1 million to 148.6 million rubles.

In view of the evidence of squandering at the Cherepovetsk Metallurgical Combine, measures were adopted to utilize subassemblies and equipment of the continuous billeting mill remaining after the reconstruction, worth 1110.0 thousand rubles, for repair of the existing equipment. Those guilty of long neglecting to use the equipment of the continuous billeting mill at the Cherepovetsk Metallurgical Combine have been called to account.

As a first priority, measures were taken to place in service, in the years 1988-1989, facilities having previously purchased imported equipment. The financial problems for bringing this equipment on line have been completely solved.

The article "Imports—Waiting To Be Claimed" was thoroughly discussed at an open party meeting of the equipment administration.

Plight of Soviet Metal Industry

18420272b Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 8 Jul 88 p 2

[Article by Yu. Zvezdin, general director of the NPO TsNIITmash [Scientific-Production Association of the Central Scientific Research Institute of Machine-Building Technology]: "How to Restrain the Appetite?"]

[Text] In production of comparable items, we expend three times more metal and energy resources than the United States. Why? There are several reasons. One of the foremost—we are continuing to live in the "Iron Age." Only 5 percent of all structural materials of the machine industry are nonmetallic. A huge disproportion. And one that will probably continue into the near future. Meanwhile, it is not because we do not have good alternative materials—ceramics, polymers, polyurethanes, fiberglass, etc. All these are well known substances. Technologies have even been mastered for them. But it is only single pieces or very small lots. Mass production is not possible, if only because there is no industrial base for this.

Such a base must be created....

But how? By developing another target program and compelling its execution? But we have learned more than once how ineffective such a route can be. Especially today, when the enterprises are becoming increasingly self-sufficient. One cannot compel them to do much of anything. And self-financing (khozraschet) is only a hindrance in the present situation. After all, self-financing is, first and foremost, economic self-interest. But why should machine builders make extensive use of more expensive, scarce, and little-studied nonmetallic materials, when commercial production in value terms while maintaining the ceiling price remains the crucial planning index? And not only nonmetals. With the transition to the new management conditions the enterprises are eager to dispense with the high quality, but expensive steel of the Oskolskiy Electrometallurgical Combine.

That is to say, there is no demand for highly effective structural materials in the machine industry. Consequently, there is no motivation to pursue their production. Only in certain areas of technology where the object of labor, and not economics, is the determinant, such as the space or aviation industry, are the sophisticated materials used rather extensively.

For the machine-building complex, the principle of "the end justifies the means" is no longer applicable. But our economic science, I believe, has simply overlooked this fact. There are still no clear-cut criteria for the effectiveness of the use of metals on a nationwide level. There is no concept of resource savings predicated upon the economic self-interest of the manufacturers. It is still necessary to rely on the individual directive parameters or standards, which in no way enunciate an economic approach to the solution.

Perhaps I am speaking heresy, but the definition of the control figures in terms of lower consumption of metals and energy, properly viewed, is nothing less than a holdover from the practice of regulating everyone and everything. Indeed, many managers, and even collectives, have accepted these figures as a tangible and (let me emphasize) ultimate goal. They hunt for ways to "shave off" 2 or 3 kilograms from the weight of a mass-produced machine. That is, they are using the old methods to accommodate themselves to the declared strategy, to report about restructuring. But in fact, reduction in consumption of materials and energy is not at all the goal. Nor even the means to the end. It is merely the outcome of rational labor. Try to imagine a Western entrepreneur setting himself the goal of reducing metal consumption by a certain percentage. Is this not ridiculous? His goal is profit. In the struggle for the consumer, this is only possible with a continual search for new product quality and strict rationalization of production. Therefore, the indexes of the effectiveness of the outlay of resources are needed by the businessman only for economic analysis, future forecasting, but not by any means as the end goal. Whereas we are still entangled

with them. And a further paradox: we cram mutually exclusive things into our plans—lower metal consumption and increased delivery of metal scrap.

The cardinal problem, of course, can only be solved by economic means—when the wasting of resources will be truly unprofitable. But either then or now, we cannot avoid major technical and administrative transformation. For example, it is necessary to revise the structure of the consumption of metals and to provide for more extensive introduction of modern processes of forming, both in metallurgy and in the machine industry. Let us take presswork. Given the acute scarcity of metal and the funded redistribution of production, many plants have had to expand continually the capacities of their billeting departments. Sizable manpower and resources are invested in the casting departments. But it has long been known that steel presswork is nearly twice, and iron presswork more than one and a half times cheaper than castings. This does not mean that casting should be abandoned altogether. But it is high time for a drastic reduction in its volume. A simple comparison: we produce 17 million tons of cast pig iron per year. The United States, only 6. But nearly half of this is high strength iron, whereas only 3 percent of ours is such.

Why don't the Americans need so much cast metal? A dialectical process is at work: not only does quantity become quality, but quality becomes quantity. Western machine builders make extensive use of precision shapes and are constantly improving the metal smelting technology. All of this provides a 20-30 percent improvement in the physiocomechanical properties of the metals and, hence, a sizable savings on them.

We must especially stress the fact that reduction in metal consumption is something of a chain reaction. Let us say we have succeeded in somehow reducing the aggregate weight of machine products. Thus, less metal is needed. Consequently, the volume of mined ore must be cut back. With less mining, there is no need for so many mining excavators, high capacity dump trucks, railroad cars, metal working lathes, equipment for smelting, rolling, forging.... In short, by the feedback principle, the volumes of machine production will drop. And again, this necessitates a lowering of the level of mining.... and so on in a spiral, loop after loop. A vivid example of this is the fact that the United States produced 122 million tons of steel in 1970. But in 1986, only 75.

Yet we are mining 5 times more iron ore than the United States! And we are continuing to expand the production of metals, which (loop by loop) dictates an increased production of equipment for those purposes. Is it any wonder that other sectors—light industry, the food industry—are technologically backward? The machine industry neglects them almost completely. In the apt expression of Vasiliy Selyunin ("The Growth Rate on the Scales of Consumption," SI, 5 Jan), this industry is becoming increasingly self-devouring. No more than a tenth of its production is produced for direct consumption. The remainder serves the raw material and other sectors of heavy industry.

How to break the vicious circle? It is necessary to start (I am convinced) with the first process stage of the machine industry—the billeting department. It is necessary to organize the production everywhere of high-quality metal products in a broad assortment. And in small lots. This is not profitable to metallurgy, either ferrous or nonferrous. But it is urgently necessary for the machine industry.

Our association, along with the USSR Academy of Sciences, the Ukrainian SSR Academy of Sciences, the All-Union Gosplan, and the NPO VNIImetmash [Scientific-Production Association of the All-Union Scientific Research and Planning-Design Institute for Metallurgical Machine Building] has developed a proposal for creation of modular metallurgical complexes with capacity of 10-100 thousand tons of molten metal per year. This would be steel of high purity and, thus, excellent quality. Compared to the grades being used at present, one-third as much will be needed. The technology is based on a revolutionary design of the High Temperatures Institute of the USSR Academy of Sciences. The complexes are to be outfitted with a new generation of metallurgical units created by the VNIImetmash. According to the results of a preliminary study and discussion, this should be a highly effective industry. Furthermore, compared to conventional metallurgy, it will be infinitely better in regard to the ecology, the sanitary-hygienic conditions, and the attractiveness of the work.

Let me make myself clear. We have ventured upon a radical restructuring in economics. And the key to this is raising the machine industry to a new quality phase. The old framework will not fit here, just as the prewar 1-and-1/2 ton truck could not be modernized into a present-day BelAZ.

In short, radical solutions cannot be avoided. Our proposed system of regional miniplants is one such solution. Our "casting center" will supply a group of machine building plants with high quality billets, which by their very selves will dictate a progressive lowering of the metal consumption and the volume of lathework.

As a start, we are planning to create a kind of prototype: a module for continuous casting of billets will be constructed on the foundation of the Chekhov Power Machinery Plant. Apart from everything else, this is intended as an advertisement, a publicity event, something for the industrialists to see firsthand. The working model will be far more convincing than enthusiastic speeches, sketches and blueprints.

Then again, the complex could not be built in a week. By the time that it is ready, one would hope that the price and rate situation is cleared up, if only in general terms. Production of billets will become profitable, while transport of castings over thousands of miles unprofitable. And events themselves, by economic stimuli, will prod the enterprises and even the cooperatives to take part in the creation of the regional "casting centers."

In conclusion, let me say that I realize not everyone will agree with such proposals. But constructive criticism can only help. I stand ready to discuss and debate the issue.

UDC 620.193.43

Corrosion of Austenitic Steels in Melted Sodium Tetraborate and Boron Oxide

18420019a Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 16 Mar 87) pp 1-4

[Article by V. P. Kochergin, S. S. Nokhrin, A. B. Teterin, M. M. Vladimirova, and V. V. Lozhkin, Urals State University imeni A. M. Gorkiy]

[Abstract] Results are presented from determination of the corrosion resistance of a number of austenitic steels and Armco iron, cobalt, and nickel in melted sodium tetraborate to which boron oxide was added. It was found that the mean corrosion rate of austenitic steels alloyed with nickel, molybdenum and tungsten decreases in a tetraborate melt. References 12: all Russian.

UDC 669.15'3-154:537

Resistivity and Layer Separation in Liquid Fe-Cu-C Alloys and Copper-Containing Cast Iron

18420019b Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 1 Dec 87) pp 6-9

[Article by G. V. Sakun, V. V. Singer, Ye. D. Kudryavtseva, A. B. Shminke, I. A. Montilo, and I. A. Radovskiy, Urals Polytechnical Institute]

[Abstract] At certain temperatures and concentrations, an iron-copper-carbon melt may separate into copper-rich and copper-poor layers. This article presents studies intended to provide additional information on the trinary system Fe-Cu-C and the influence of sulfur on the area in which copper-containing cast iron separates into layers. The rotating magnetic field method was used to study the temperature and concentration variation of resistivity of melts as well as liquid copper-containing cast iron with 2 percent carbon, 1.42 percent sulfur and 0.11 percent phosphorus. Copper content varied from 0 to 60 percent in the alloys, 3.5 to 16 percent in the cast iron. Layer separation was observed in liquid Fe-Cu-C alloys containing 2 percent C, and in copper-containing cast iron with similar composition. References 3: 2 Russian, 1 Western.

UDC 669.046:621.326

Metal Refining Kinetics in the Oxygen-Converter Process

18420019c Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 24 Nov 86) pp 31-34

[Article by G. A. Tarnovskiy, A. V. Yavoyskiy, and A. M. Sizov, Moscow Steel and Alloys Institute; Urals Scientific Research Institute of Ferrous Metallurgy]

[Abstract] The kinetics of the oxygen-converter process are described, assuming that the liquid metal is intensely agitated throughout the entire volume of the converter except for the boundary layer near the phase interface. Equations are derived providing a mathematical description of the kinetics of the oxygen-converter process in the form of the material balance, in which the speed of refining is equal to the algebraic sum of the kinetic and quasi-equilibrium processes: $V\,dc/d\tau=RC_0-RC-\beta S\,(C-C_i$; $V\,dC/d\tau=RC_0-RC-\beta SC$. References 6: 2 Russian, 4 Western (in Russian translation).

UDC 669.18.046.518-412-181.2:621.746.019

Crust-Zone Chemical Heterogeneity in Rimming Steel Ingots

18420019d Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 25 May 87) pp 34-36

[Article by R. P. Konovalov, Institute of Ferrous Metallurgy, Dnepropetrovsk]

[Abstract] A comparative study was made of the development of chemical heterogeneity in the crust zone of two cast ingots of type 08kp steel of the following composition, in percent: 0.10 C; 0.39 Mn; 0.019 S; 0.020 P. A boron-containing slag-forming mixture was placed in the mold before pouring of one of the ingots (experimental ingot). Significant chemical heterogeneity was found to develop in the crust zone of the control ingot, whereas the slag-forming mixture significantly reduced the content of harmful impurities (sulfur, phosphorus) in this zone in the experimental ingot, yielding superior physical-mechanical properties in the sheet metal made from the ingot. References 4: 3 Russian, 1 Western.

UDC 541.136.24

Influence of Electron Component of Conductivity in $ZrO_2(Y_2O_3)$ on Accuracy of Oxygen Activity Determination in Liquid Steel

18420019e Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 30 Mar 88) pp 41-45

[Article by A. V. Molodchikov, V. P. Luzgin and I. V. Zinkovskiy, Moscow Steel and Alloys Institute]

[Abstract] Experiments were performed to determine the critical oxygen partial pressure at which the fraction of ionic and electronic conductivities are equal in solid electrolytes of $ZrO_2(Y_2O_3)$ under laboratory conditions. About 500 g of carbonyl iron were melted in an alundum crucible and oxygen activity measured using two oxygen-concentration elements with different electrodes. An equation is presented to compute the influence of the electron fraction of conductivity of the ceramic on the emf of a concentration element immersed in liquid steel. Throughout the range of partial oxygen pressures in the liquid steel (from 10^{-9} to 10^{-16} Pa) at 1550-1650°C, the mean ionic fraction was closer to one when powdered Mo-MoO_2 mixtures were used as the comparison electrode. References 8: 1 Russian, 7 Western.

UDC 621.771:620.19.001.5

Surface Defects in ShKh15 Rolled Steel Products

18420019f Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 10 Jun 86) pp 46-49

[Article by Ye.L. Zats, Yu.V. Klimov, A.G. Ponomarenko, S.F. Parakhina, V.P. Kravchenko, B.P. Krikunov, R.P. Oleksa and S.M. Grishchenkova, Donets Polytechnical Institute, Donets Metallurgical Plant imeni V.I. Lenin]

[Abstract] A study of type ShKh15 rolled steel products indicated that the products with worst surface defects corresponded to the lower portion of the original ingot. Specimens were taken for detailed metallographic examination. Groups of thin hair-like cracks were observed, accompanied by significant secondary oxidation. Larger cracks with significant edge spreading were also found, usually partially filled with scale. A study was made of the composition of large nonmetallic inclusions in the metal in comparison with that of furnace slag and the slag formed from the mixture when the metal was poured. The studies indicated that the reason for the poor surface quality in this type of steel product is contamination of the ingot with particles of the insulating mixture due to intensive agitation of the metal during the initial portion of pouring. References 3: all Russian.

UDC 621.771.011

Influence of Kinematic Boundary Conditions on Stress-Strain State in Flat Rolling

18420019g Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 9 Feb 87) pp 50-55

[Article by A.V. Nogovitsyn, Institute of Ferrous Metallurgy, USSR Ministry of Ferrous Metallurgy, Dnepropetrovsk]

[Abstract] In this article, suggested by the editors to stimulate discussion, the author derives an equation for computation of the vortex stress at the boundary between the metal and a roll of a rolling mill, considering that there are zones of slipping and of adhesion. A finite-difference model of flow of the metal is used to study the influence of the length of an adhesion zone on rolling parameters. The mathematical model of viscous-plastic flow developed shows that when high strips are rolled with l/h_{av}=0.55-1.0, the length of the adhesion zone does not significantly influence the stress-strain state in the deformation focus. As l/h_{av} increases, the influence of the length of adhesion zones becomes significant. The editors note that the method used by the author has the significant defect that it is difficult to join the solution produced to the field of velocities in the external parts of a strip. The author presents boundary conditions which attempt to overcome the difficulty, but the editors disagree with the use of these boundary conditions. References 5: 3 Russian, 2 Western (in Russian translation).

UDC 621.73.011:539.214

Study of Stress-Strain State on Free Surface of Cylindrical Specimen in Upsetting

18420019h Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 8 Jul 87) pp 55-58

[Article by V.K. Vorontsov, S.A. Mashekov, V.A. Petrov and A.V. Kotelkin, Moscow Steel and Alloys Institute]

[Abstract] The process of deformation occurring during upsetting was studied in time, approximating height deformation as a function of time by series, splines, Chebyshev polynomials, and other methods to smooth and differentiate the experimentally obtained values with respect to time. Calculations were performed using deformation theory and flow theory. Analysis of the kinematic and statistical parameters of the upsetting process show that at less than 50 percent compression the results of computation by deformation and flow theory agree. Further increases in compression result in great differences of the results of computation. The deformation process becomes nonmonotonic at 30-60 percent compression. For greater compressions, the flow

theory is preferable. Use of multistage deformation to determine the kinematic and statistical parameters of the process results in great errors. References 3: all Russian.

UDC 621.7.011

Selection of Energy-Saving Mode of Hot Blank Cyclical Deformation
18420019i Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 8 Oct 86) pp 59-61

[Article by V.N. Yefimov, L.N. Sokolov and V.I. Baran, Kramatorsk Industrial Institute]

[Abstract] The problem of decreasing the cyclical deformation energy of a hot blank can be formulated as selecting the method resulting in the minimum work of cyclical deformation from among all possible cyclical deformation methods. This article studies the case of isothermal deformation with a single pause with constant cycle length and length of working deformation sections. The deformation rate is assumed constant. An equation is derived for the goal function, which can be used in selecting efficient, energy-saving methods for cyclical upsetting of large ingots. References 4: all Russian.

UDC 621.77.01

Method of Determining Nature of Metal Plastic Flow During Helical Rolling
18420019j Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 2 Jul 86) pp 61-63

[Article by A.N. Nikulin, V.K. Shumilin, I.G. Getiya and T.K. Shirokova, All-Union Correspondence Machine-Building Institute]

[Abstract] A method is presented for determining the nature of plastic flow of metal during deformation on industrial or laboratory equipment, based on the use of special study specimens. A notch is cut in a blank, then filled with a homogeneous metal of different chemical composition which interacts very little with the metal of the matrix, perhaps by plasma spraying. The metal is then deformed, cut and examined. The method determines the distribution of flow through the cross section of the metal, nonuniformity of deformation distribution through the height of the specimen, shear deformation, etc. References: 1 Western.

UDC 620.17:669.14.018.29

Influence of Monitored Rolling on Mechanical Properties of Low-Pearlite Steel
18420019k Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 20 Feb 86) pp 67-70

[Article by V.K. Potemkin, V.A. Peshkov, V.N. Khloponin, A.D. Belyanskiy, I.Yu. Zakharov and V.G. Yermolayev, Moscow Steel and Alloys Institute]

[Abstract] Cooling of a rolled product in an intermediate conveyor and the temperature at which rolling is begun in the finishing group of stands determine the condition of austenite before the final rolling stage; rapid cooling of hot-rolled strips on the final conveyor influences austenite decomposition and phase segregation. This article studies the influence of cooling conditions in these stages on the mechanical properties of low-pearlite steel on 5 and 18 mm rolled strips produced from 240x1100 mm slabs of type 08G2SFB steel produced by the oxygen converter process and continuous casting. Allowing the intermediate rolled product to cool to not over 850°C for thick strips, 950°C for thin strips before the finishing stage of rolling achieves the desired level of cold resistance in the pipe steel. Rapid cooling after rolling to about 500°C at no less than 4°C/s increases strength properties by 20-30 percent while maintaining the desired ductility and impact toughness. References 4: all Russian.

UDC 621.98.011

Hot Drawing of Pipe With Wall Thickness Reduction
18420019l Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 8 Jul 87) pp 71-74

[Article by V.N. Chudin]

[Abstract] A study is made of a steady process of pipe drawing with wall-thickness reduction in a conical die with the deformation focus heated under isothermal conditions to about 50 or 70 percent of the melting point. The pipe material is assumed to be a relaxing, transversely isotropic metal with some normal anisotropy. The problem of the pipe drawing force required with a moving mandrel is solved by the maximum-limit energy method suggested earlier by the author. The problem is also solved in the same formulation for the process of hot pressing. The computations require that the viscosity of the deformed metal be considered, using creep mechanics equations of state. The experimental data indicate the correctness of an equation of state based on the theory of aging for warm operations, the

theory of flow for hot operations. Engineering computations based on the theory of creep using the maximum-limit method yield results satisfactory for practical purposes. References 6: all Russian.

UDC 621.771.23:539.374

Degree and Rate of Deformation During Rolling
18420019m Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 25 Nov 86) pp 74-78

[Article by V.F. Potapkin, Kramatorsk Industrial Institute]

[Abstract] The method of slip line fields is used to study the influence of deformed and kinematic state irregularities in a deformation focus on the degree and rate of deformation on the contact surface. The deformation focus model used is a field of slip lines, allowing peculiarities of the deformed and kinematic states in the deformation focus to be considered. The equations derived indicate that heterogeneity of the deformed and kinematic states during rolling has a great influence on the degree of deformation on the contact surface. References 7: all Russian.

UDC 620.17:539.376

Creep and Fracture of Continuous-Cast Steel
18420019n Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 26 Aug 87) pp 83-86

[Article by Yu. I. Boytsov and V. L. Danilov, Moscow Higher Technical School imeni N.E. Bauman]

[Abstract] There is very little information on the short-term creep of steel at temperatures over 80 percent of the melting point. The lack of a standard scientifically well-founded method for high temperature testing of materials makes it difficult to gain more information. This article presents studies of such creep on type 20 steel (composition, percent: 0.23 C, 0.55 Mn, 0.29 Si, 0.26 Cr, 0.14 Ni, 0.033 P, 0.025 S) at 1123 to 1573 K (65-90 percent of the melting point). Mathematical planning of the experiments reduces the number of experiments required and ensures the necessary reliability of individual experimental results. Specimens of predetermined shape and dimensions must be used. The method suggested involves comparatively slow heating followed by long-term holding with protection from scale formation provided by argon. References 11: all Russian.

UDC 669.018.5:620.183

Structural Changes During Heat Treatment of Isotropic Electrical Steel
18420019o Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 21 Dec 87) pp 86-91

[Article by L.A. Prisekina and Yu.I. Larin, Lipetsk Polytechnical Institute; Novolipetsk Metallurgical Combine]

[Abstract] A study is made of the influence of the temperature and length of heat treatment of hot-rolled strips, as well as of recrystallization annealing parameters after cold rolling, on the structural changes of isotropic electrical steel. Studies were performed on electric furnace and converter made steel and melts subjected to vacuum degasing in the liquid state. The grain size, composition and number of nonmetallic inclusions were studied on metallographic microscopes, a scanning electron microscope and an x-ray microanalyzer. Structural changes during heat treatment depend on initial composition of the hot-rolled strip, temperature and time annealing parameters, density and dispersion of nonmetallic inclusions and tensile stresses applied during annealing. Over 0.20 percent copper hinders recrystallization in the central layers of strips, displacing it to higher temperature ranges. Primary and secondary recrystallization during decarburizing and recrystallization annealing are influenced by the quantity of dispersed nonmetallic inclusions, heating rate and holding time and temperature. Heating in an atmosphere of moist nitrogen displaces primary recrystallization to lower temperatures and causes structure and texture changes which improve the magnetic properties of the finished steel. References 2: both Russian.

UDC 669.14.018.298

Influence of Phosphorus and Sulfur on Structure, Texture, and Mechanical Properties of Two-Phase Ferrite-Martensite Steels
18420019p Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 28 Nov 87) pp 100-104

[Article by L.M. Storozheva, N.M. Fonshteyn, L.G. Skorokhodova and A.N. Nishchenko, Institute of Ferrous Metallurgy, Dnepropetrovsk; Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] A study is made of the influence of phosphorus and sulfur on the structure, crystallographic texture and mechanical properties of two-phase ferrite-martensite steel produced under laboratory conditions. Heat treatment was by heating to 810°C, holding for 10 minutes and quenching in oil or water with subsequent low-temperature tempering at 200°C for 15 minutes. As

phosphorus content increased from 0.003 to 0.071 percent, a crystallographic texture was formed which was favorable for drawing, increasing the normal plastic anisotropy coefficient. Strength characteristics increased, uniform elongation decreasing somewhat. Increasing sulfur content and the quantity of manganese sulfides decreased the stability of the austenite upon cooling from the critical temperature interval; the addition of cerium somewhat levelled the negative influence of sulfur on mechanical properties. References 10: 7 Russian, 3 Western.

UDC 621.746.628:669.13

Crystallization of Cast Iron Upon Addition of Copper

18420019q Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 2 Feb 87) pp 104-110

[Article by V. I. Krayevoy, Ye. I. Belskiy and P. I. Popov, Belorussian State Institute of the National Economy]

[Abstract] Copper has a complex influence on the eutectic graphitization of hypoeutectoid cast iron. Two groups of synthetic low-silicon melts with a carbon equivalent of 3.8 and 5.6 were generated to produce a qualitative estimate of the influence of copper on primary crystallization of hypoeutectoid and hypereutectoid cast irons. The chemical composition was (in mass percent): C 3.73 and 5.51, Si 0.25, Mn 0.3, S 0.04, P 0.05. Cooling curves were recorded with a potentiometer and platinum-platinorhodium thermocouples protected by quartz tips. Hardening structural analysis was performed to determine the nature of the distribution of phases rich in copper in the liquid state by taking rod-shaped specimens in the 1600-1300°C temperature interval and quenching them in water. Copper was found to be a graphitizing element at concentrations not over the solubility limit of copper in the liquid phase. Otherwise it prevents graphitization during eutectic crystallization and facilitates chilling. The structural conversions occurring in high-copper hypereutectoid cast iron indirectly indicate that during primary crystallization the stable phase segregated from the liquid is graphite rather than cementite. Primary cementite is formed in a peritectic reaction between the liquid and graphite at near the eutectic temperature. References 4: 3 Russian, 1 Western.

UDC 669.041:620.191.32

Influence of Scale Formation on Heat Exchange Intensity in Continuous Furnaces

18420019r Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 31 Mar 87) pp 123-126

[Article by N.P. Kuznetsova and G.I. Kolchenko, Moscow Steel and Alloys Institute]

[Abstract] A mathematical model of the heating of metal in continuous furnaces suggested in a previous work is supplemented by a modulus describing the process of scale formation, which changes the radiation characteristics of heat-receiving surfaces and isolates metal products beneath a layer of low-conductivity scale. The model assumes growth of a layer of oxides on the upper surface of an endless plate, with continuous breaking of the scale on the lower surface, no change in total product thickness during heating and liberation of the oxidation reaction heat on the outer surface of the scale. The influence of scale formation on heat transfer was analyzed for the conditions of heating of carbon steels in continuous pusher furnaces, determining the variation in heat conductivity of the scale as a function of temperature, the apparent thickness of the oxide layer and empirical scale growth coefficients at temperatures of 450-1550 K. The results indicate that the use of more gradual slab surface heating inhibits scale growth and stabilizes the radiation characteristics of the scale, intensifying radiative heat transfer. References 2: both Russian.

UDC 66.041.38:621.365

Thermal Effect of Electric Arcs on Arc Steel Making Furnace Tamped Linings

18420019s Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 2 Nov 87) pp 128-131

[Article by V. M. Soyfer, N. I. Mosolova, V. D. Smolyarenko, and L. Ye. Nikolskiy, Moscow Evening Metallurgical Institute]

[Abstract] A study is made of the thermal effect of arcs on the tamped monolithic lining of acid-lined five-ton furnaces 2350-2700 mm in diameter following exposures of 50-140 minutes to the arc. The distribution of arc radiated power on the lining surface was determined in a small-scale model; then the distribution data were used in a mathematical model to study the process of lining wear as a function of furnace geometry, arc radiated power and time of exposure. A one-dimensional mathematical model of the heating of a multilayer lining was used, assuming that oxides and slag from the furnace space penetrate into the lining, changing its structure and decreasing heat resistance, and crystallize within the tamped layer, causing failure. The distance between the arc and the wall and the time of exposure to the open arc are found to be the most important factors determining heating and wear of linings. Furnace designers should attempt to limit the oxidation and reduction periods and vary arc radiated power to minimize lining damage. References 4: all Russian.

UDC 669.184.01-52

Optimizing Interaction of Steel Making Equipment in System With Continuous Casting

18420019t Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 17 Dec 86) pp 140-144

[Article by Ye. N. Derkachev, D. V. Makovskiy, S. V. Yefremov, and M. P. Makovskaya, Moscow Steel and Alloys Institute]

[Abstract] The problem of optimizing the interaction of

individual technological processes is solved within the framework of a steel making system consisting of oxygen converters, steel-pouring ladles, installations for blowing argon through the steel and continuous casting machines, based on various organizational and technological criteria. Effective operation of converter production as a whole is achieved by composing the optimal dynamic operating schedule for all of its technological sections. The problem of optimizing the interaction of steel making system units is formulated as the problem of finding the best dynamic schedule for the technological processes from the standpoint of preselected criteria, corresponding to the situation at hand in the shop. At the Novolipetsk Metallurgical Combine the total increase in steel production is 18,250 tons per year, the expected economic effect 116,160 rubles per year. This effect is achieved by improving the productivity of the system while reducing the length of the technological cycle by decreasing downtime of major equipment. References 3: all Russian.

UDC 621.762.2:66.013.8

Catalysis of Combustion of Exothermic Mixtures Containing Ferrosilicon
18420019u Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 7, Jul 88 (manuscript received 7 Jan 88) pp 162-163

[Article by I.V. Babaytsev, L.A. Fedorov and V.V. Shilin, Moscow Steel and Alloys Institute]

[Abstract] One means of improving the safety of the processes involved in preparing and using exothermic mixtures is to replace metallic powders in the mixtures with ferrosilicon. This article studies the possibility of using a number of fluorides produced in the Soviet Union to increase the speed of combustion of such mixtures. The most effective catalyst is found to be sodium fluoride.

UDC 621.74.002.6:669.14

Structure and Properties of Castings of Gray Iron Reinforced With Steel Fibers
18420276a Moscow LITEYNOYE PROIZVODSTVO in Russian No 6, Jun 88 pp 7-8

[Article by F. D. Obolentsev, doctor of technical sciences, V. B. Kurushin, candidate of technical sciences, and Ye. I. Litvinova, candidate of technical sciences]

[Abstract] An experimental study of SCh 20 gray iron cast with steel (0.1-0.6 pct C) wires 1-4 mm in diameter was made for a determination of its structure and properties. Cylindrical castings 100 mm high were produced by pouring the melt into painted steel molds, some 50 mm and some 100 mm in diameter, at three different temperatures: 1593 K, 1633 K, 1673 K. The optimum reinforcement was established on the basis of the mathematical "reinforcement-matrix-ambient medium" model and minicomputer-aided calculations by the method of function series. Seven nomograms have been constructed on the basis of calculations and measurements for design of the reinforcement and prediction of the casting characteristics such as time of excess heat removal and mechanical strength depending on the ratio of wire diameter to wire spacing, the volume fraction of wire, and the ambient temperature. References 1: Russian.

UDC 621.74:669.131

Composition of Chromium Cast Iron
18420276b Moscow LITEYNOYE PROIZVODSTVO in Russian No 6, Jun 88 p 8

[Article by A. D. Leshchenko, engineer, A. F. Kuzovov, candidate of technical sciences, and V. V. Lunev, doctor of technical sciences]

[Abstract] An experimental study of high-chromium cast iron with 2.2-3.4 pct C and 13-30 pct Cr was made, for the purpose of determining the composition dependence of its hardness, wear resistance, and mechanical strength as cast or after normalizing. Other alloying elements were up to 1 pct Ni, sufficient for ensuring hardenability of 60-80 mm thick castings, as well as 0.6-0.9 pct Mn and 0.6-0.9 pct Si. An evaluation of the data by the method of regression analysis indicates that the optimum composition range for application not requiring mechanical forming is 2.7-3.4 pct C and 16-23 pct Cr, whether the cast iron is normalized or not. References 1: Russian.

UDC 621.74.002.6:669.14

Economy Alloy Steel for Castings Operational at High Temperature
18420276c Moscow LITEYNOYE PROIZVODSTVO in Russian No 6, Jun 88 p 9

[Article by S. N. Bogomolov, engineer, Yu. V. Yudin, engineer, Yu. A. Karasyuk, candidate of technical sciences, and M. A. Gervasyev, candidate of technical sciences]

[Abstract] A cast alloy-economy steel for construction of metallurgical equipment operating at temperatures up to 600 deg C has been developed, this 20CrMoVSi steel to replace cast 20CrMo (0.6 pct Mo) steel now used for such applications. It contains less scarce molybdenum, only 0.13 pct, but more Si (0.9 pct) with 0.1 pct V and 0.03 pct Ti added so as to maintain the same quality level. Both steels acquire a homogeneous fine-grain structure within the 870-930 deg C austenitizing temperature range and both need to be normalized at a temperature 30-50 deg C lower so as to avoid intense grain growth. Castings need to be tempered at 630-650 deg C, a temperature higher than the maximum anticipated service temperature, to ensure structural stability and retention of mechanical

strength. The highly disperse V and Ti carbides forming in this steel strengthen the ferrite matrix, accelerate the growth of pearlite clusters, and comminute the grains.

UDC 621.74:669.14.255

Formation of Carbides in Cast Multialloy Roller Steels
18420276d Moscow LITEYNOYE PROIZVODSTVO in Russian No 6, Jun 88 pp 9-10

[Article by A. A. Filippenkov, candidate of technical sciences, M. A. Olikhova, candidate of technical sciences, A. G. Ryzhkov, engineer, and P. L. Litvinenko, engineer]

[Abstract] An experimental study of cast hypereutectic 150CrNiMo alloy steel used for rollers in rolling mills has confirmed the feasibility of improving the roller performance by the addition of V and Ti to this steel. This study, conducted by the Ural Scientific Research Institute of Ferrous Metals (Engineers A. N. Podust and N. K. Sherstnev) jointly with the Ukrainian Scientific Research Institute of Metallurgy and the Institute of Ferrous Metals as well as the Metallurgical Combine imeni A. K. Serov and the Nizhniy-Tagil Metallurgical Combine imeni V. I. Lenin, has revealed the heretofore unknown fact that in hypereutectic steels of this class there can occur an eutectic reaction resulting in formation of complex carbides in the gamma-phase. In this case either (V,Cr)C or (V,Ti)C carbides will form, depending on the V, Cr, Ti content. References 2: both Russian.

UDC 621.74:669.71

Mechanical and Casting Characteristics of Al-Si-Cu and Al-Si-Zn Alloys Modified by Addition of Strontium
18420276e Moscow LITEYNOYE PROIZVODSTVO in Russian No 6, Jun 88 pp 10-12

[Article by O. N. Semenova, candidate of chemical sciences, I. N. Ganiyev, candidate of technical sciences, T. M. Karimova, engineer, and M. Makhmudov, candidate of chemical sciences]

[Abstract] A comparative evaluation of eight cast Al-Si-Cu alloys and 10 cast Al-Si-Zn alloys with respect to mechanical characteristics (yield strength, percentage elongation, impact value) and fluidity, as well as with respect to electrochemical characteristics, has revealed that the addition of Cu, Mg, Ti to Al-Si-Zn alloys lowers their castability, while addition of 0.05 pct Sr to all these alloys improves their mechanical characteristics with an only slightly lower castability. Addition of Cu, Mg, Ti has also been found to decrease the corrosion resistance of these alloys, as indicated by tests in 3 pct NaCl solution. References 4: all Russian.

UDC 621.745.35:621.365.2

Magnetohydrodynamic Distributor Furnace
18420276f Moscow LITEYNOYE PROIZVODSTVO in Russian No 6, Jun 88 p 21

[Article by I. I Kovalevskiy, candidate of technical sciences]

[Abstract] A magnetohydrodynamic distributor furnace (USSR Patent No 1381737) for metal casting is shown which differs from conventional MHD pumps based on the principle of an induction channel furnace with iron core. Here the liquid metal poured into the crucible forms a closed secondary loop on a closed magnetic core, just as in a transformer. It is heated and maintained liquid by alternating current induced in it upon application of an alternating voltage to the multiturn primary winding. The induced current also transports the liquid metal from the furnace to the ladle. The crucible of this furnace is partitioned vertically so that its full capacity can be utilized for pouring, melting, mixing, and storage, while the partition confines the entire current within the liquid metal flowing through a V-channel with a vertical tube in its lower part driven by theelectromagnetic pressure drop. Short heatup time and forced heat transfer contribute to a high efficiency of this furnace. References 4: all Russian.

UDC 669.15'24'28:666.046.516:539.372:538.22

Influence of Plastic Deformation and Alloying on Magnetic Properties and Structure of Alloys for Permanent Magnets Based on the Fe-Mo-Ni System
18420009a Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 65 No 6, Jun 88 (manuscript received 16 Dec 86) pp 1075-1080

[Article by L. M. Magat, G. M. Makarova, T. P. Lapina, Ye. V. Belozerov, V. G. Maykov, N. N. Shchegleva, N. F. Shilova, and Ya. S. Shur, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] A study is made of the effect of great plastic deformation on the hysteresis magnetic properties of alloys in the Fe-Mo-Ni system, obtained after annealing. The influence of the addition of gallium on the magnetic properties of the alloys is also studied. It is found that great plastic deformation increases the coercive force of the alloys, while gallium facilitates retention of ductility of the alloys with higher molybdenum content, additionally increasing the magnetic characteristics. References 3: 1 Russian, 2 Western.

UDC 541.12.03/48,76,23

Nonstoichiometry and Physical Properties of $CdCr_2Se_4$ Ferromagnetic Semiconductor

18420293c Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24 No 7, Jul 88 (manuscript received 13 Feb 87) pp 1089-1093

[Article by N. K. Belskiy, L. I. Ochertyanova, V. A. Zhegalina and L. I. Koroleva, General and Inorganic Chemistry Institute imeni N.S. Kurnakov, USSR Academy of Sciences]

[Abstract] A study is presented of the influence of variation from stoichiometric composition on the properties of cadmium chromium tetraselenide magnetic semiconductor. Several electrical and magnetic parameters were measured and the nature of point defects was studied. The ferromagnetic Curie temperature, paramagnetic Curie-Weiss temperature and effective magnetic moment were found to vary among specimens of slightly different composition. Only strict monitoring of composition can permit comparison of the physical properties of different specimens of magnetic semiconductor materials. Reduced selenium and cadmium content with excess chromium decreases the resistance of specimens by two orders of magnitude and reduces thermal emf by a factor of 10. The predominant defect type is thought to be vacancies in the anionic or cationic sublattices. References 17: 13 Russian, 4 Western.

UDC 620.172.251.2:539.4

Method for Comparative Estimation of Crack Resistance of Heat-Resistant Steels in Early Creep

18420294a Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 54 No 7, Jul 88 (manuscript received 1 Apr 87) pp 70-74

[Article by V.I. Gladshteyn and I.I. Trunin, All-Union Heat Engineering Scientific Research Institute imeni F.E. Dzerzhinskiy]

[Abstract] An analysis of fracture kinetics during creep is presented using as the basis for standardization of the methodology the fact that, regardless of the mechanism of crack formation during creep, the rate of crack growth is determined by thermal activation processes. In order to provide a reliable comparison of the reliability of the materials in various structural states in the initial stage of creep, the stress levels causing a given speed of crack growth at equivalent values of geometric factors must be compared. The results of computations indicate the need to study the influence of the structural status of steel on its tendency to fail during long-term use. References 15: 12 Russian, 3 Western.

UDC 666.762.852.017:620.187

Electron Microscope and Miscoscopic X-Ray Spectral Study of Polycrystalline Silicon Carbide with Added Cr_2O_3

18420017a Moscow OGNEUPORY in Russian No 8, Aug 88 pp 30-36

[Article by S. V. Kazakov, V. I. Kolynina, Ye. Ya. Litovskiy, and G. G. Melnikova, All-Union Institute of Refractories]

[Abstract] Studies of the structure of polycrystalline silicon carbide with added Cr_2O_3 were performed by the method of scanning electron microscopy and x-ray spectral microanalysis using powdered silicon carbide, carbon black and chromium oxide. The studies demonstrated that addition of Cr_2O_3 to the initial charge can result in production of a monolithic polycrystalline silicon carbide framework. At the optimal chromium oxide content of about 2.2 percent, the material has high strength and good electrophysical properties. References 16: 5 Russian, 11 Western (5 in Russian translation).

UDC 622.368.2:66.046.512]:621.365.2

Effective Control of Arc Furnace Electric Conditions for Production of High Quality Periclase

18420017b Moscow OGNEUPORY in Russian No 8, Aug 88 pp 36-38

[Article by V. V. Avtukhov, V. P. Tikhonov, and I. I. Lapayev, Krasnoyarsk Nonferrous Metals Institute, V. A. Zvantsev and G. P. Zhilin, Northern Angara Mine]

[Abstract] The Northern Angara Periclase Plant undertook six experimental periclase melts with various operating modes of the current regulator of the arc furnace, with air blown into the arc zone through two hollow electrodes and the exhaust gases evacuated through a third hollow electrode. Analysis of the results produced indicated that the yield of first class periclase increased by an average of 12.5 percent, that of second class periclase decreased by 14.9 percent, while furnace productivity decreased by 20.2 percent. For the first time at this plant, periclase of the highest quality category was produced, meeting the state standards for grade PPE-VM. Thus, in spite of the lower productivity of the furnace due to the reduced voltage used, the new operating conditions are desirable because of the high quality periclase produced. References 1: Russian.

UDC 621.762

Structure Formation Upon Rapid Crystallization of Aluminum-Iron Alloys
18420004a Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 32 No 8, Aug 88 (manuscript received 2 Sep 87) pp 718-721

[Article by A.S. Kalinichenko, I.Yu. Kupriyanova, P.A. Parkhutik and I.S. Chebotko, Physical Technical Institute, Belorussian Academy of Sciences]

[Abstract] A study was made of the structural peculiarities and properties of rapidly crystallized Al-Fe alloys as a function of their composition and cooling rate. Alloys containing 1-10 mass percent iron were heated to 100°C above the liquidus. Cooling rates were 10^2-10^6K/s. The microstructure and microhardness of the alloys were measured, precision x-ray structural analysis performed, and the lattice parameters determined in specimens and granules. It was found that the increase in concentration of the iron in the solid solution with increasing cooling rate was not monotonic, but rather determined by a complex interatomic interaction of metastable phases segregated from the melt, their composition, number and distribution in the structure. The combined hardening effect resulting from supersaturation of the α phase with iron and the reduction in primary intermetallide grain size allow a high level of mechanical properties to be achieved in extruded semifinished products. References 7: 4 Russian, 3 Western.

UDC 543.42:669.2

Use of Spectral Method With Induction Plasma to Determine Nonferrous Metal Impurities in Steel
18420294b Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 54 No 7, Jul 88 (manuscript received 12 Nov 86) pp 110-112

[Article by I. M. Dolganyuk, N. N. Peykhvasser, Ye. T. Mikhaylova, A. M. Dobrinskaya, and V. G. Buryanov, Oskolskiy Electrometallurgical Combine imeni L.I. Brezhnev]

[Abstract] In order to decrease the time required to determine lead, antimony, zinc, tin, and bismuth in steels, the authors selected a spectral method with an induction plasma as the source of excitation. The method features low limits of detection, good reproducibility and little influence of the presence of one element on the results of theanalysis of others. Studies were performed on an atomic emission spectrometer manufactured in Australia with a theoretical resolution of 97600 and input slit width of 20 μm. Determination of the various elements is briefly described. References 5: 3 Russian, 2 Western.

UDC 621.762

Scale Resistance of Synthetic Hard Tool Materials

18420003a Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 130 No 2, May 88 (manuscript received 26 Feb 87) pp 389-392

[Article by Z. G. Aslamazashvili, A. N. Pityulin, G.S h. Oniashvili, D. M. Samkharadze and G. G. Sarishvili, Metallurgy Institute imeni the 50th Anniversary of the USSR, Georgian Academy of Sciences]

[Abstract] A study of the scale resistance of synthetic hard tool material type STIM-3V was performed in comparison with previously developed type STIM alloys and some industrial hard alloys. Differences in oxidation rates of the materials were found to be quite great. Industrial tungsten-containing alloys VK8 and T5K10 oxidized particularly rapidly. Specimens swell due to intensive formation of tungsten oxide. Tungsten-free alloys oxidize more slowly, though the oxidation rate depends on their composition. STIM-3V, upon synthesis and rapid cooling, forms the carbide $C3_{23}C_6$, but it does not decompose due to the replacement of some of the chromium atoms with iron atoms forming the carbide $Cr_{16}Fe_7C_6$, practically completely preventing oxygen from reaching the (Ti, Cr)C grains. The minimum oxidation rate is observed when the material contains 10 wt. percent of Kh18N15 steel. References 6: all Russian.

UDC 536.421.4:669.715'891

Characteristics of Eutectic Crystallization in Al-Cu Alloys Under Zero Gravity

18420275d Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 88 (manuscript received 9 Oct 87) pp 43-47

[Article by S. Ya. Betsofen, S. A. Maslyayev, V. N. Pimenov and Ye. B. Rubina, Moscow]

[Abstract] An experimental study of Al - 5 Cu and Al - 30 Cu alloys was made for the purpose of determining the effect of weightlessness on the crystallization of eutectics in them. The crystallization texture was determined on the basis of inverse pole figures in the direction of the temperature gradient using a DRON-2.0 x-ray diffractometer with CuK_{alpha}-radiation source and a textureless reference specimen. Both alloys were produced in space flight and, for comparison, on earth. The results reveal an appreciable effect of weightlessness, the effect being quite different in each alloy. The mechanism of eutectic crystallization in the 95-5 alloy was found to be growth of alpha-phase on its existing grain boundaries and crystallization of theta-phase, under better equilibrium conditions on earth. The mechanism of eutectic crystallization in the 70-30 alloy was found to be growth of both phases in the interdendritic space, under better equilibrium conditions without gravity, both phases crystallizing independently and with mutually independent orientations. It has been established in an earlier study that a lesser than 001 greater than$_{alpha}$ parallel to grad T texture is produced under better equilibrium conditions than is a lesser than 011 greater than$_{alpha}$ parallel to grad T texture. References 5: 4 Russian, 1 Western.

UDC 669.292'849:621.785:537.312.62

Influence of Heat Treatment on Structure and Superconducting Transition Temperature of Vanadium-Rhenium Alloys

18420009c Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 65 No 6, Jun 88 (manuscript received 16 Feb 87) pp 1105-1109

[Article by Ye. K. Stribuk, Solid State and Semiconductor Physics Institute, Belorussian Academy of Sciences]

[Abstract] V-Re alloys were produced by melting in an arc furnace with tungsten electrode, eliminating all possible sources of contamination of the liquid metal. The specimens were then cut by diamond-copper discs into several plates for x-ray phase analysis and preparation of microsections for measurement of microhardness and study of the microstructure. Additional specimens were cut to measure the transition temperature to the superconducting state using both the resistive and the inductive methods. All alloys studied were subjected to high-temperature heat treatment at 2023 and 2173 K under a vacuum with constant evacuation. Hardened specimens had an α-solid solution based on vanadium with bcc structure, an σ phase with β-U structure and a β phase with hcp structure. Annealing at 60-69 at. percent rhenium broke the α-solid solution down into an σ phase with β-U structure and a type A-15 phase with Cr_3Si structure. References 8: 5 Russian, 3 Western.

UDC 543.423

Determination of Nonferrous Metal Impurities In Ferromolybdenum and Ferrotungsten By Spectral Photoelectric Method

18420294c Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 54 No 7, Jul 88 (manuscript received25 Mar 87)pp 113-114

[Article by A. K. Tumanov and T. G. Tumanova, Chelyabinsk Electrometallurgical Combine]

[Abstract] A method of spectral determination of impurities in ferromolybdenum and ferrotungsten has been developed, significantly decreasing the time required for determinations by replacing photographic recording of the spectrum with photoelectric recording and by eliminating a number of supplementary operations by changing the principle of the organization of specimen evaporation. The temperature of the evaporated volume of a specimen is held to that optimal for evaporation of the

impurities and not allowed to rise to the point that the base metal of the specimen starts evaporating by the use of a pulsed arc discharge and a moving electrode, selecting a combination of electrode speed, arc parameters and specimen layer thickness such that each individual discharge forms a portion of melted powder, while several discharges never act on the same portion of powder. Optimal analysis conditions are: specimen layer thickness 1-1.5 mm, electrode gap 3-4 mm, electrode movement speed 0.5-1 mm/s, arc current 8-10 A, pulse repetition frequency 0.5-10 Hz, pulse length 0.05-0.25 s.

UDC 669.25'871:535.33/.34

Interzonal Optical Absorption In Co_xGa_{100-x} Compounds

18420009b Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 65 No 6, Jun 88 (manuscript received 21 Jan 87) pp 1096-1099

[Article by L.V. Nomerovannaya, V.I. Anisimov, N.A. Popova and N.B. Gorina, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] A study is made of the frequency dispersion of optical conductivity in Co_xGa_{100-x} compounds to explain the peculiarities of electron structure, which are of significance for selection of a model describing all the anomalies of the physical properties in this system. The optical properties are studied in the 1-10 eV spectral area at room temperature. The index of refraction and of absorption are measured at E=1-5 eV by a polarimetric method. Reflectivity is measured in the 5-10 eV area and the frequency dispersion of optical functions is computed. It is found that the appearance of a peak in the state density near the Fermi level determined by considering structural defects can qualitatively explain the additional optical absorption at E less than 0.8 eV in comparison to an ideal crystal. The structural defects result in the formation of new peaks in the state density curve, restructuring of electron states near the Fermi level and, consequently, appearance of additional absorption in the low-energy area of the spectrum. References 11: 4 Russian, 7 Western.

Adhesive-Welding Methods Introduced in Truck Production at ZIL

18420022 Moscow MOSKOVSKAYA PRAVDA in Russian 3 Sep 88 p 1

[Article by A. Kichatov]

[Excerpt] "What kinds of joining methods do we know?", asked V. S. Lapin, head of the nonmetallic coatings laboratory of the Moscow Automotive Plant imeni Likachev (ZIL). "Welding, soldering, and bolts are conventional and well-known. The addition of adhesives to this list has been greeted with skepticism by some specialists."

Specialists of the Ministry of the Automotive Industry (Minavtoprom) have long been following original work which Ukrainian chemists are doing on development of polymer adhesives. The objective of these scientists was to develop an adhesive which would require no preparatory operations. Spread it on a joint, join both parts together and the product is ready.

Such an adhesive has now been developed. It contains active substances which clean the surface of a part themselves, preparing it for cementing. New types of adhesives called "Sprut" and "Styk" and others excellently join materials into "metal-metal", "plastic-metal", and "plastic-plastic" combinations.

The new polymer adhesives face one of their most serious tests at ZIL. Preparations for series production of a new diesel truck, the "ZIL-4331", are in full swing here. The latest Soviet and imported equipment is being installed and tested, and new processes, including adhesive joining processes, are being perfected in shops.

Technologists of ZIL and the developers of the adhesives have found real industrial uses for them. A process for obtaining adhesive-welded joints has been developed as a result. Two plane surfaces are cemented, and the joint is then strengthened by spot welding along the seam. The adhesive thus bonds and seals at the same time.

Automotive-parts joints of the new type have undergone thorough testing for impact and fatigue strength and resistance to corrosion at a proving facility of the Central Scientific Research Institute of Automobiles and Automotive Engines. Rigorous examiners gave the innovation a ration of "excellent".

G. I. Selyamet, deputy head of Minavtoprom's main scientific-technical administration, commented: "A clever engineer will find many uses for the new adhesives."

UDC 666.651.5

Thermally Stable Zirconium Ceramic

18420008a Moscow STEKLO I KERAMIKA in Russian No 7, Jul 88 pp 22-23

[Article by F.Ya. Kharitonov, doctor of technical sciences, O.A. Sheronova, A.Ye. Volokhov and G.F. Dobrynin, engineers, All-Union Scientific Research and Design-Technological Institute of Electroceramics; Perm High-Voltage Electric Insulator Plant]

[Abstract] The purpose of this work was to develop products of zirconium ceramic containing about 80 percent zirconium concentrate with small quantities of clay, marble, talc and magnesium carbonate. The introduction of zirconium chamotte at 5, 10, 15 and 20 percent was tested to determine the possibility of using process wastes. Standard specimens were pressed, roasted at 1320°C and their physical and technical characteristics determined. The data indicate that introduction of up to 20 percent chamotte has no significant influence on the physical and technical characteristics of the specimens. The Perm High-Voltage Electric Insulator Plant used material containing 15 percent zirconium chamotte to manufacture products for arc-damping chambers in electromagnetic breakers. References 2: both Russian.

UDC 661.55

Production of Aqueous Suspensions Based on Silicon

18420008b Moscow STEKLO I KERAMIKA in Russian No 7, Jul 88 pp 26-28

[Article by V. F. Tsarev, candidate of technical sciences, and N. I. Ipatova, engineer]

[Abstract] A study is presented of the possibility of producing aqueous suspensions based on silicon suitable for the molding of blanks of complex shapes over 160 mm in height. It was found that the silicon interacts with water during grinding, liberating gaseous products. The silicon was ground in a ball mill of 300 liters capacity lined with corundum plates. It was possible to grind the material to the required particle size by preventing aggregation of the milled material into large lumps on the balls and walls of the mill. Additional moisture had to be added and the suspension hydromechanically agitated and stabilized with electrolytes to allow molding. Addition of electrolytes during stabilization allowed a viscosity of 75 sec to be achieved after seven days. Maximum density of finished products was achieved at pH=0.5-0.8. References 2: 1 Russian, 1 Western.

UDC 666.593

Nondestructive Optical Quality Testing of Ceramic Products

18420021a Moscow STEKLO I KERAMIKA in Russian No 8, Aug 88 pp 17-18

[Article by G.I. Berdov, doctor of technical sciences, P.N. Pletnev, candidate of technical sciences, A.M. Kiselev, engineer, S.A. Stepanova, candidate of technical sciences, and V.N. Nikiforova, engineer, Novosibirsk Construction Engineering Institute]

[Abstract] A study is made of vacuum-tight ceramic materials in the visible light spectrum. The light transmission of the materials was studied using an incandescent bulb as the light source and a photomultiplier or spectrophotometer as the light receiving unit. It is found that the light transmission of the ceramic products reflects their degree of sintering and microstructural peculiarities. The method of transmission is suitable for the manufacture of automatic testing equipment. It allows testing of 100 percent of products manufactured and is highly productive. References 3: all Russian.

UDC 666.5.022.69

Rheologic Properties of Porcelain Mass Exposed to Silicate Bacteria

18420021b Moscow STEKLO I KERAMIKA in Russian No 8, Aug 88 pp 20-23

[Article by A.N. Chernyshov, engineer, A.S. Vlasov, doctor of technical sciences, S.N. Vaynberg and V.P. Skripnik, candidates of technical sciences, Dmitrovskiy Porcelain Plant, Moscow Chemical Technology Institute imeni D.I. Mendeleyev, MoldNIIstromproyekt]

[Abstract] A study was made of the rheologic properties of commercial porcelain specimens treated by a preparation of silicate bacteria. A porcelain mass containing 60-62 percent water was treated with silicate bacteria for five days with constant agitation at 25-26°C, then dewatered to 22-24 percent, dried at 60-70°C to 0 moisture content, crushed and screened. A slip casting mixture with 32 percent moisture content was then prepared and held for 48 hours. It was found that the bacteria produced various substances which acted as hydrophilic surfactants, decreasing the strength of contacts between particles and thus reducing the viscosity of the system. The adsorbed surfactants produced can reduce the quantity of electrolyte which must be introduced to liquefy the porcelain, thus reducing the corrosion of gypsum molds and increasing the speed of collecting fragments. These properties are retained for a long period of time. References 5: 3 Russian, 2 Western.

UDC 539.16

Maximum Temperature of Target Subject to High-Intensity Ion Implantation

18420275c Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 88 (manuscript received 30 Jun 87) pp 39-42

[Article by Yu. L. Zabulonov, N. V. Makarets and A. M. Fedorchenko, Kiev]

[Abstract] Doping of semiconductor crystals by high-intensity ion implantation without leaving residual radiative defects is considered, a crystal being heated to temperatures at which recrystallization occurs either epitaxially or from the liquid phase. The temperature field and maximum temperature in a target are calculated analytically on the basis of the corresponding one-dimensional equation of transient heat conduction depthwise for a thin target with a large surface and with arbitrarily temperature-dependent specific heat, thermal conductivity, as well as density of the material, the boundary conditions being heat radiation from the free surface and heat transfer to the substrate from the back surface. This equation is solved first for long bombardment time, when the total dissipation becomes comparable with the ion beam power and the maximum target temperature is most readily reached. This temperature is determined on the basis of the corresponding steady-state equation with a constant temperature gradient, first for the special case of a thermal conductivity independent of the temperature and then for the more general case of one inversely proportional to it. A higher temperature uniform over the target thickness is reached in the latter case, but otherwise the temperature fields are similar in both cases. At a fixed ion beam power and with heat dissipation in both directions, the target temperature becomes higher as the target thickness is decreased. The original equation is also solved for short pulses of ion bombardment, in which case only the surface layer is heated and the high temperature gradients produced as a result stimulate thermal diffusion. References 7: 5 Russian, 2 Western (1 in Russian translation).

Laser Drilling Under Water

18420035 Moscow PRIRODA in Russian Aug 88 p 103

[Abstract from a letter to ZHURNAL TEKHNICHESKOY FIZIKI, Vol 13 No 17, pp 1055-1058]

[Text] Specialists at the Institute of General Physics of the USSR Academy of Sciences have examined the possibility of drilling metals under water. The radiation of even the most powerful continuous-operation lasers is able to penetrate no more than a few centimeters into water due to the great absorption that occurs. Therefore, in order to deliver this radiation to even shallow depths, they plan to use a light guide (as is done in cutting materials in air using a beam from a yttrium-aluminum-garnet [YAG] laser). If the end of the light guide is a few centimeters from the surface to be worked, then a beam from even a very low-power laser can perform the task because of the vapor-gas bubble that is formed. Unlike arc-welding of metals under water, where the bubble between the electrode and the metal consists mainly of hydrogen due to the high temperature of the arc, leading to "embrittlement" of the weld, the use of the laser makes it possible to reduce the temperature in the bubble to almost that of the melting point of the metal and thus to avoid this undesirable phenomenon.

Experiments were carried out using a 100 W continuous neodymium YAG laser. Specimens of titanium foil 60 microns thick were laid horizontally in a dish holding 3 cm of water. Drilling was initiated as of the time that the bubble formed, when the temperature of the specimen rose sharply; with a high beam power the drilling was completed even before the bubble formed. For each depth to which the specimen was immersed, there was a particular critical beam power above which drilling became possible; this power increased exponentially with depth.

The experiments showed that the presence of the vapor-gas bubble is very important to the drilling process. Suffice it to say that when there is no bubble, the drilling goes about 100 times slower at the same laser power. The authors note that due to the high convective heat transfer into the water, the area where the specimen is heated up is several times smaller than when holes are drilled in air. Thus, holes drilled under water are considerably more "precise" than those made in air using the same tool.

The composition of the surface compounds that form in the heated area was studied by drilling holes in a sheet of titanium through a standard layer. The composition of the coating formed was found to be complex and included carbides, oxides, carbohydrides and oxycarbides of titanium. Custers of the form C - (n=1, 2, ..., 16) were also noted. It is possible that laser working of materials under a layer of liquid hydrocarbons may become a way of forming not only protective carbide layers, but also carbon films.

UDC 535.211:620.18

Localization of Reaction and Sharpening of Temperature Profile During Laser Heating of Metals

18420275b Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 88 pp 19-26

[Article by V. A. Bobyrev, F. V. Bunkin, N. A. Kirichenko, B. S. Lukyanchuk and S. A. Ubaydullayev]

[Abstract] Formation of localized heat dissipating structures on a metal surface heated by a laser beam and oxidizing in air is analyzed on the basis of theoretical relations and experimental data. Solution of the corresponding two equations which describe transient heat

conduction and oxidation kinetics respectively, assuming a Gaussian laser beam, yields the conditions for sharpening the surface temperature profile and thus increasing the temperature gradients with an attendantly shrinking site of more intense oxidation reaction. This is demonstrated on the case of a long and thermally thin metal plate and an endothermic oxidation reaction, but is also valid in the case of an exothermic reaction. Experiments were performed with 0.5 mm thick Ti, Co, Zr targets having a surface area of 3x30 mm^2 and with an ILGN-704 40 W Co_2-laser. Some radiation was diverted by an NaCl beam-splitting plate to an IMO-2N power meter and a cylindrical mirror focused the remainder of radiation within an elliptical spot 0.5 mm wide and 6 mm long on the target surface. The temperature distribution was measured with 13 Chromel-Alumel thermocouples. Other instrumentation included an MBI-9 microscope, an SI-82 oscillograph with an amplifier-commutator, and a Kiev 16-UE motion-picture camera with an STTs-1 watch-timer. The amplifier gain was varied over the 1-300 range and the switching frequency was varied over the 1-130 kHz range. The results generally confirm the theoretical prediction, localization of oxidation and sharpening the temperature profile requiring a laser beam with an only initially nonuniform intensity distribution. References 8: all Russian.

UDC 621.791.18:669.85/.86+669.012.29

Diffusion Welding of Intermetallic Alloys With Structural Steels
18420022a Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 pp 1-2

[Article by G.N. Fedyukina, candidate of physical-mathematical sciences, Ye.V. Dolgikh, candidate of physical-mathematical sciences, and V.P. Karmanov, engineer, Tyumen Industrial Institute imeni Leninskiy Komsomol]

[Abstract] Results are presented from an experimental study of diffusion welding of the alloys $TbFe_2$ and $SmFe_2$ with structural steel using an intermediate layer of copper. Cylindrical specimens 6 mm in diameter and 1-10 mm in length were used. The strength of the joints produced with 20-40 μm thick copper foil at 900-950°C for 15-60 minutes with residual pressure in the vacuum furnace of 1.33 mPa was determined by mechanical tensile testing. The quality of the joints was studied by metallographic analysis of sections perpendicular to the contact surface. Strong joints were obtained at 920-950°C in $TbFe_2$+ steel, 800-850°C for $SmFe_2$+ steel. The use of the copper foil yielded good quality welded joints without requiring great smoothness of the surfaces to be joined. References 6: 5 Russian, 1 Western.

UDC 621.791:763.2:669.141.24+669.295

Splashing in Projection Welding of Titanium With Steel
18420022b Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 pp 4-5

[Article by O.G. Bykovskiy, candidate of technical sciences, I.V. Pinkovskiy, candidate of technical sciences, S.N. Minyaylo, engineer, Zaporozhye Machine Building Institute imeni V.Ya. Chubar, V.R. Ryabov, doctor of technical sciences, Electric Welding Institute imeni Ye.O. Paton, and V.V. Tarasov, engineer, Gorkiy Polytechnical Institute imeni A.A. Zhdanov]

[Abstract] A study is presented of the conditions of the development of internal splashing and its significance in the formation of titanium-steel joints by projection welding. Welded spot formation was studied as type VT1-0 titanium specimens 2 mm thick and type St3 low-carbon steel specimens 10 mm thick were welded. Welded joints were judged by determining their cohesive strength and minimum titanium thickness in the welded spot. It is suggested that splashing be controlled by thermomechanical activation of parts as they melt together and subsequent mechanical treatment to clean the welded spot zone. This forms an effective joint between the metals in the liquid-solid phase through a thin intermetallic interlayer. References 3: 2 Russian, 1 Western.

UDC 621.791.947.55

Plasmotron for Plasma-Mechanical Cutting of Blanks
18420022d Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 p 24

[Article by M.A. Shaterin, candidate of technical sciences, V.S. Medko, candidate of technical sciences, and V.V. Platonov, engineer, Leningrad Polytechnical Institute imeni M.I. Kalinin]

[Abstract] Two plasmotrons have been constructed at the authors' institute for plasma-mechanical cutting, based on a type PRV-101 unit with a modified plasma-forming body feed system and nozzle. The modifications have reduced the width of the plasmotron from 28 to 18 mm. Diagrams and descriptions of the devices are presented. The reduced width of the new designs allow it to fit into the slot it cuts. It can operate with series-produced power supplies. Technical characteristics are: Arc current, 100-200 A; arc length, 20-45 mm; nozzle aperture diameter, 2.5-4 mm; voltage, 140-200 V; plasma-forming gas flow rate, $2m^3$/hr.

UDC 621.793.72:669.13

Repair of Cast-Iron Rollers by Arc Surfacing With Gas-Plasma Protection
18420022e Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 pp 28-29

[Article by P.A. Tyvonchuk, candidate of technical sciences, V.N. Naumenko, engineer, and P.V. Kosmatskiy, engineer, All-Union Scientific Research and Technological Institute for Repair of Machine Parts; Remdetal All-Union Scientific-Production Association]

[Abstract] The authors' institute has developed a technological process for repair of worn surfaces of rollers by applying a layer of steel by arc surfacing with gas-plasma protection using natural gas or a propane-butane mixture and oxygen. The new method can apply a compact layer of steel, the hardness of which is close to the hardness of the base metal. Surfacing can be performed on an installation based on a lathe or a surfacing machine. Surfacing is performed on a helical line in 1-3 passes. Typical electrode diameters, separation distances and rotating speeds are described. Compact steel layers are applied to worn gray cast iron surfaces, achieving hardness close to that of the cast iron. Hardening by spraying with a cooling liquid is suggested. References 2: both Russian.

UDC 621.791.92:621.791:621.9.06

Repair of Parts by Discrete Application of Detonation-Gas Coatings
18420022f Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 p 30

[Article by M.I. Livshits, candidate of technical sciences, Zaporozhye Motorostroitel Production Association]

[Abstract] A process for the repair of worn part surfaces has been developed involving atomization of a layer of type Kh20N80 steel up to 5 mm thick on a universal type UDK-11 detonation-gas machine. The coatings are not applied as a continuous layer, but rather as individual unconnected spots. The coated sections are applied in sequence, with one spot generated by each shot of the machine. The number of 25-50 mm diameter spots applied and the distance between them are selected depending on the dimensions of the surface to be repaired. The advantages of the method are the decreased cost of the repair process and the increase in repairability achieved by applying coatings 0.6-5 mm thick. References 4: all Russian.

UDC 621.791.052:669.017.3

Influence of Yttrium on Diffusion of Carbon in Welded Joints
18420022g Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 pp 32-36

[Article by N.G. Yefimenko, candidate of technical sciences, and L.N. Balan, candidate of technical sciences, Ukrainian Correspondence Polytechnical School imeni I.Z. Sokolov]

[Abstract] Results are presented from a study of the influence of yttrium on diffusion of carbon in welded joints of similar and dissimilar steels. Carbon migration was studied by ^{14}C autoradiography, with the labeled isotope introduced to the type 20 steel base metal as it was made in induction furnaces. Surfacing was performed in two layers onto different steel specimens, one of which contained 0.3 percent yttrium by mass, using austenite electrodes and electrodes made of type 30 steel containing yttrium. It was found that yttrium added to the base metal decreased the diffusion of carbon toward the fusion line with steel alloyed with strong carbide-forming elements. Yttrium is found to attract carbon toward compounds such as oxides, sulfides and oxisulfides, forming complex oxycarbosulfide, oxycarbide and other systems. These compounds firmly hold the carbon atoms at high temperatures, causing discrete distribution of carbon in the base metal with yttrium. This process of attraction of carbon by yttrium results from the great chemical affinity of these elements. The compounds formed do not have the high hardness characteristic of the carbides of strong carbide formers. The use of yttrium can decrease the carbon gradient at the fusion boundary, decreasing the diffusion flow of carbon toward the fusion line. References 2: both Russian.

UDC 621.791.052:520.192.47

Influence of Solubility Jump in the Hydrogen-Aluminum System on Formation of Porosity in Welding
18420022h Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 88 pp 38-39

[Article by Ye.A. Bulgachev, candidate of technical sciences, A.F. Nesterov, candidate of technical sciences, N.B. Boytsov, engineer, and M.Yu. Markov, engineer, Moscow Aviation Technological Institute imeni K.E. Tsiolkovskiy]

[Abstract] A model is suggested for the process of pore formation during welding of aluminum in the presence of hydrogen, assuming the formation of hydrogen porosity as the phase interface moves in liquid aluminum due to an increase in the concentration of the hydrogen to greater than the concentration in the main mass of the liquid. In the central area of a welded seam, the concentration of dissolved hydrogen slightly exceeds the maximum of 0.69 $cm^3/100$ g, resulting in the formation of hydrogen porosity. The correctness of the model suggested was demonstrated experimentally. References 5: 3 Russian, 2 Western (in Russian translation).

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